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Cables :: "Stomata." | Phone :: 2183

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AGRICULTURAL POLICY IN THE LESSER ANTILLES.

IN these days of low prices, it is generally realized that the effort to establish agriculture on a basis as near permanently profitable as possible must be governed by two cardinal points of agricultural policy. Firstly, the crop must be of very high quality, and must be produced as economically as is practicable, and secondly, it should be bulked and graded by some responsible organization to ensure uniformity of material for the buyer. Both points have been commonplace for so long now that it might seem fatuous to mention them. Yet a survey of the methods of production of the chief tropical crops, both in the West Indies and elsewhere, reveals the fact that, although these considerations are accepted as belonging to the fundamentals of planting, the lacuna between what is possible in this direction and what is actually done is still unnecessarily great.

What are the handicaps? How might they be overcome?

Regarding the first point, high quality, it is clear that whatever the crop may be a variety of plant yielding a high-grade product is needed. In the absence of seedsmen, the Departments of Agriculture can take the lead here, under the aegis of various botanical research stations. Already Government stations in various parts of the West Indies are propagating the best types of cacao, cotton, sugar-cane, citrus, and, where required, banana, so that the planter can be confident that the material which reaches his estate from such sources is of the most satisfactory type. Assuming that the planters in a given area have secured supplies of uniform plant material of the most suitable variety, is it safe to make the further assumption that the plants will receive the treatment most suitable to ensure the realization of their potential bearing capacity? Observational evidence indicates that, in many cases, the answer is in the negative. The question is by no means entirely one of available money—room for improvement too frequently lies in the elements of planting procedure. Plants have reasonable limits of toleration, and, on this account, such practices as planting at rather unsuitable times, and in rather unsuitable places, have not revealed the mistakes inherent in such methods sufficiently to ensure their correction. When a planter finds his crop failing completely, he takes stock of the situation; it is when an estate is paying

its way with a reasonable margin of profit that the planter tends to make his chief mistake —that of not calculating how far his average yield falls below the best yield of his area.

When a crop is paying, the most natural reaction on the part of the planter is to put more land down to its cultivation. Commonly this is of very low productivity, and though its produce may help to swell to some extent the total yield of the estate, a fall in prices may easily make such fields completely profitless and a burden on the estate as a whole. The incentive to plant in unsuitable spots is very great; most planters do not have sufficient experience to realize how unsuitable their choices may be. This is exemplified in every West Indian colony: coconuts are seen planted in swamps; cotton struggles for existence on slopes too steep for cultivation, or grows unprotected on the uplands of the more breezy islands; limes are found in similar situations, or grown beneath coconuts; examples can easily be quoted with regard to bananas and cacao. Scientific investigation has shown that such practices are unprofitable in cacao cultivation at least. The operation of the Cacao Relief Scheme in Trinidad is designed to discourage cultivation of this type. And rightly so. The whole tendency of modern agriculture is towards intensive methods.

Future policy must be framed on the assumption that labour will become dearer, that prices for produce will maintain a relatively low level, and that profit must be made by concentrating on obtaining the maximum yield from the best land available, and not maintaining any low yielding areas. Just how this ideal of high-scale farming may be attained depends mainly on the major crop involved in each case. In questions of suitability of land the Departments of Agriculture are in a position to consult authorities on the subject. They, too, can supply selected plant material. In the case of annual crops, such as tomatoes or cotton, it is very desirable for Planters' Associations to obtain advice regarding the scientific aspects of their agricultural practices; it does not follow that a system which has produced crops for many years is necessarily the best that can be employed. In the planting of cotton, for instance, the use of heavy seed-rates is both wasteful and costly—the same result could be obtained with less seed and consequently less thinning later. Yet heavy seed-rates, sanctioned by usage, form part of the current practice in many parts. The time of planting also might well be subjected to scientific scrutiny. The heavy use of seed is not infrequently to be traced to the fact that planting is carried out at a time when seedling mortality is likely to be very high, whereas an adjustment of planting date would provide the seedling with an environment much farther within its range of tolerance. Further, the attempts to increase total yields of annuals by extending the area under cultivation, instead of concentrating on raising the yield of the best areas, result in the planting season being unduly prolonged—so much so that it is possible to see cotton being picked on an estate which contains at the same time fields of seedlings a few inches high. The planting season is prolonged because it would be too expensive to call in extra labour to plant the additional areas at the normal planting time. Such late planted cotton, unless favoured by exceptional weather, tends in large measure to be reaped in poor condition, and to suffer heavily from attack by disease.

With regard to manuring, there is a general tendency to apply quantities which are definitely insufficient, or even to omit the operation altogether. This is mainly on account of the system of extensive agriculture. The number of plants requiring manure is high, and the average yield per plant low, and it is felt that the total expense on manure might possibly swallow up what additional profit the crop might bring in. Where intensive methods are employed in conjunction with manuring, however, not only does the yield per acre reach a figure far beyond that considered good for an extensively grown crop, but the fertility of the land is maintained at a high level. This is an essential agricultural requirement, which is largely ignored because the consequences are not of importance to the present generation.

Tropical crops respond well to manuring and experiments on the manuring of sugar cane and cacao are already under way. This is definitely a step in the right direction. In some parts, cotton is given a dressing of fertilizer, and it is felt that this could very usefully be tried in areas where it is not now the practice. Citrus is somewhat favoured in this respect, but even so the amount of attention given to the trees is relatively little, and manuring is carried out very much by rule of thumb. In many cases no treatment whatsoever is given.

In the drier portions of several of the islands it is known that citrus trees have to withstand a very unfavourable period of drought during the dry season. Any contributory cause of weakening of the tree may lead to severe wilting, dieback, or death. It is beginning to be recognised that decided benefit is to be obtained from irrigation where this is feasible. Quite apart from the fact that trees are brought back into a relatively healthy condition, flowering and fruit-setting are accelerated. Even here, however, there is ground for criticism. Cases have been noted where the planter has run the water down channels set well away from his trees, unaware that they have developed a surface root system, and that this is only slightly affected by the seeping from the channels. The same amount of water in such cases would have been much more efficiently distributed had it been carried at a moderate distance round the trunks of the trees in a series of connected loops. Now there is a danger that the fairly satisfactory result of the first attempt will remove any incentive to adopt a more efficient system, and in this, as in

so many other operations, establish a tradition of mediocre agricultural practice which will be all the more difficult to remove as time goes on.

Finally, there is far too much neglect in the matter of recording yields and costs. Many planters do not keep accounts at all. They cannot state what a given price for produce means to them in terms of profit or loss. Efficient accounting need involve the planter in little or no expense, and enables him to appreciate the monetary significance of his various agricultural operations. In some countries, such as South Africa, citrus farmers are urged to keep a crop history of every tree on their estates, so that trees giving consistently inferior yields can be removed. While this excellent system is somewhat idealistic as yet for the West Indies, planters can obtain some of its advantages by keeping separate records of the various fields on their estate. They would then be in a position to differentiate between their 'good' and 'bad' lands, and to apportion their expenditure on the estate according to the return likely to be obtained, thus preventing waste of money on unprofitable fields.

Here and there are to be found planters who are striving towards intensive methods. Scattered effort of this kind, however, often cannot reap its full reward; the individual planter cannot hope for price discrimination in favour of the superior quality of his crop. All estates must make it their aim to produce for markets where low prices prevail, and must seek better prices by better production and co-operative marketing methods. To-day, even more than in the past, it is necessary for West Indian planting practices to be kept abreast of changing conditions by continual scientific investigation, and agriculture to be established on an intensive basis, supervised by Government where necessary, before the islands can become dependably profitable and the standard of living of their inhabitants raised.

THE CHEMICAL COMPOSITION OF BANANA TRASH.

By G. Rodriguez.
(*Analyst, Imperial College of Tropical Agriculture.*)

Data pertaining to the chemical composition of different parts of the banana plant are meagre and scattered in the literature, but such results as have been published indicate that *potash* is by far the most abundant and characteristic mineral component of the ash. In a paper recently published in this Journal (1), A. F. Baillon, E. Holmes and A. H. Lewis have given analytical figures for the composition of various parts of the Cavendish banana grown in the Canary Islands. The entire plant contains in its dry matter, 5.36 per cent. of potash, 1.11 per cent. of lime, 0.68 per cent. of magnesia, and 0.29 per cent. of phosphate. Of the different parts of the plant, the *fruit-stalk* contains most potash (40 to 60 per cent. of the total ash), whilst the leaf and the leaf-stem contain least potash (30 per cent. of the ash). The amounts of lime are the reverse, fruit-stalk containing least, and leaf and leaf-stem most lime. This reciprocal relationship between potash and lime is a distinctive feature of the chemical composition of plant material of many agricultural crops.

Different types and species of banana contain different amounts of potash, even when grown under similar conditions and in similar soil. Thus, D. W. May (3) gives the following figures for potash content presumably of the whole plant:— Gros Michel, 2.9 per cent., Manzano, 1.8 per cent., Lady's Finger, 3.7 per cent., Red, 4.0 per cent., Chamaluco, 1.8 per cent. and Enano (Cavendish), 12.2 per cent. of the dry matter. He stresses the possibility that a striking relationship may obtain between the potash content of banana plants and their resistance to fungous attack. Thus, Enano (Cavendish) banana is highly resistant to disease, whilst Chamaluco easily succumbs.

A Cavendish banana plant analysed by Baillon, Holmes and Lewis (1), which weighed about 40 pounds, absorbed 1½ pounds of potash, but only one ounce of phosphate from the soil. Evidently potash is a very important element in the mineral nutrition of the banana. Since many tropical soils are somewhat deficient in potash, and since potash manures are relatively expensive, it is advisable always to return the residues from banana cultivations back to the soil. Stems and leaves should be allowed to rot, and should then be buried in the soil, or incorporated into its surface layer.

It is customary to pack banana bunches in dried banana leaf-trash for transportation from the field to the shipping wharf. Usually, the used trash is thrown into the sea, or otherwise discarded as rubbish. This practice may be wasteful. In order to ascertain the extent of the possible losses, a large sample of ash obtained by incinerating waste banana leaf-trash in Port-of-Spain, Trinidad, was chemically analysed in the laboratory of the Imperial College of Tropical Agriculture. The ash sample was kindly procured and submitted for analysis by Mr. F. B. Carmichael, Locomotive Superintendent of the Trinidad Government Railways. The results obtained are presented in the following table, together with data for leaf-and

Chemical Composition of Parts of the Banana Plant.

Percentage of Ash.	Banana Trash	Fresh Leaf Material.		Fruit-Stalk Material.	
	(Trinidad)	(Mauritius)	(Canary Isles)	(England)	(England)
	Rodriguez	de Sornay (4)	Baillon et al (1)	Ellis (2)	Hanley (5)
Insol. ash (Silica) ..	52.12	11.62	—	9.61	—
Potash (K_2O) ..	5.85	31.72	29.3	45.90	59.1
Lime .. (CaO) ..	21.02	13.14	22.2	1.69	—
Magnesia (MgO) ..	5.57	9.48	7.2	1.68	—
Phosphate (P_2O_5) ..	1.39	3.60	3.8	2.74	—
Carbonate (CO_2) ..	12.31	20.31	—	31.11	—
Total	98.26	89.87	—	92.73	—
Ash Content of Dry Matter	—	8.8	(10.0 ?)	29.9	—

fruit-stalk material abstracted from published articles. The figures in each case are percentages of the total ash. The samples of Trinidad banana trash contained some unburnt carbonaceous material and a certain amount of moisture; it was therefore ignited at 600°C. before analysis, which caused a loss in weight of 13.4 per cent. of the original weight.

The ash content of the dry leaf material analysed by Baillon, Holmes and Lewis is not stated; in the table it is assumed to be 10.0 per cent., which is an average value. The ash content of the dry leaf material analysed by de Sornay was 8.8 per cent.

Conclusions.

The dry withered leaf-trash, procured in Trinidad, contains an unexpectedly *low content of potash* in the ash, as compared with that of fresh green leaf material and of leaf-stalk produced in other countries. This is probably explained by the fact that potash is the most mobile of the mineral nutrients absorbed by plants, so that it is partly withdrawn or transported out of the leaves as they pass maturity and begin to wither and dry up on the stem. Old trash lying on the ground is prone to leaching by rain, and this might further reduce its potash content, since potassium salts are all very soluble in water. Furthermore, certain potassium salts, such as the chloride, are somewhat volatile at high temperatures, so that losses may occur when the trash is incinerated, except when the temperature is kept as low as possible during combustion.

In view of these facts, it is doubtful whether the collection and incineration of banana leaf-trash is worth the trouble and expense. The unit cost of its potash content, as compared with its unit cost in imported potassic manures, is probably too high to justify its conservation and return to the soil in which the plants were originally grown. On the other hand, the collection of residual fruit-stalks in the markets where bananas are retailed overseas may be justifiable, considering the fact that about half of the fruit-stalk ash is composed of potash.

References.

(1) Baillon, A. F., Holmes, E. and Lewis, A. H., *Tropical Agriculture*, X, pp. 139-144, 1933.
(2) Ellis, R. H., *Journ. Soc. Chem. Indus.*, XXXV, p. 456, 1916.
(3) May, D. W., *Puerto Rico Expt. Sta.*, Rept. of Director, p. 7, 1927.
(4) de Sornay, P., *Rev. Agric. Maurice*, I, 7, p. 15, 1923.
(5) Hanley, J., quoted by Ellis, (2).

SUGAR AS A STIMULANT.

Professor Priestley, of Sydney University, has been advising that footballers should discontinue the sucking of lemons in the intervals of the game. What the tired footballer needs, he says, is something to supply energy without disturbance of the nervous system, and he recommends coffee with *plenty of sugar.*

Doubtless the recommendation in regard to coffee rests on the fact that coffee contains a small amount of caffein which is well-known and used as a cardiac stimulant. Sugar certainly is recommended because it is a concentrated and very readily assimilated source of energy. One pound of sugar furnishes 1,794 calories, which represents nearly two-thirds of the energy expended in a day by a man engaged in hard manual work. The assimilation of sugar takes place very rapidly, and the energy changes accompanying its resolution into carbon dioxide and water in the body, enable the individual to meet a sudden demand for heavy physical exertion with a minimum subsequent reaction.

The stimulating effects of alcohol result largely from the accelerated oxidation of the body tissue. The stimulating effects of sugar do not involve the body tissue, but result from the oxidation of the sugar itself. Thus there is no depressing reaction following the use of the latter. Further, calorie for calorie, sugar supplies energy more cheaply than any other item in the ordinary human dietary. — (*The South African Sugar Journal*, Vol. XIX, No. 12, p. 761, 1935.)

INSPECTION OF CACAO IN THE GOLD COAST.*

Departmental Policy.

In view of the acknowledged poor quality of Gold Coast cacao, and the variation in purity between bags in the same shipment, present policy in the Gold Coast Department of Agriculture aims at raising the general quality of exported cacao, and reducing the range of purities in each parcel by a compulsory system of inspection. It was early recognised that unless differential prices were paid to the farmers, they would have no inducement to exercise greater care in the reaping and preparation of the crop. As few produce in sufficient quantity to sell directly, and it is considered that the position would be improved by the grouping of producers of high purity cacao, the Department strongly encourages Co-operative action among the farmers as a means of attaining this end.

Voluntary Inspection.

As a first step, a system of voluntary inspection was instituted, and certificates were issued by the Department. Success was very limited, however, since the production and export of low quality cacao could not be curtailed by legislative methods, and the certificate did not gain the confidence of the market because the local method of estimating purity differed from that employed by merchants abroad, and, in addition, the inspection was chiefly concerned with purity, which is not synonymous with quality. In general, the object of inspection is to ensure (1) that all cacao is exported in a form which will enable it to be dealt with on the leading Exchanges under recognised contract clauses, and (2) that the cacao covered by any particular mark should be uniform throughout. The method of inspection adopted should enable examiners to reach the same decisions regarding any particular parcel of cacao, and the process itself should be inexpensive and cause as little interference as possible with normal conduct of business by exporters. To effect further improvement, cacao of very poor quality should not be exported at all, on account of its liability to injure the general reputation of the bulk of produce, and waste and foreign matter should be eliminated. Grades should be established, recognised by buyers, to form a basis for the introduction of price discrimination, because differential prices will stimulate farmers to pay more attention to preparing their cacao.

Market Standards.

Present market standards exhibit slight differences. Members of the Liverpool Produce Association and the London Cocoa Association purchase cacao by contract. Cacao sold under Clause A must not contain more than 5 per cent. slaty beans and not more than 5 per cent. of all defects other than slate. Under Clause B, governed by the same standard, cacao of lower purity can be tendered subject to price penalties. Clause C permits not more than 10 per cent. slaty beans, and not more than 10 per cent. (London) or 12 per cent. (Liverpool) of all other defects. Clause D has the same standard as Clause C, but lower purities can be offered subject to price penalties. The London Cocoa Association has a Clause E, which places no limit on slate, but stipulates that all other defects shall not exceed 12 per cent. The London Terminal Market Association does not permit its members to buy or sell cacao containing more than 15 per cent. total defects other than slate. Cacao containing between 12 and 15 per cent. defects other than slate may be sold, but not by contract. The selling and buying contracts are otherwise the same as A, B, C, D, and E of the London Cocoa Association.

Regulations made under the United States Pure Food laws have progressively been made more stringent, and since October 1933 have stipulated that cacao must not contain more than 10 per cent. of mould and weevil, and not more than 5 per cent. mould. The New York Cocoa Exchange Inc. is also governed by these regulations and provides the following classes:—(1 Slate not more than 10 per cent.; all defects other than slate not more than 8 per cent. (2) Slate not more than 10 per cent.; all other defects not more than 15 per cent. (3) Slate more than 10 per cent.; all other defects not more than 8 per cent. (4) Slate more than 10 per cent.; but all other defects not more than 15 per cent. Cacao with more than 15 per cent. defects other than slate is non-tenderable by members.

Methods of assessing defects appear to differ in the Gold Coast and London. Brokers take boldness of the beans and general degree of fermentation into consideration when valuing samples. In fact, most of the recognised commercial defects are qualitative, not quantitative, attributes. Details and standardised definitions would serve to reduce to reasonable dimensions the source of error due to variation between examiners regarding the classification of the beans, and it is recommended that such definitions should be laid down in co-operation with the leading Exchanges. As regards severity of inspection at the present time, it seems that inspection in the Gold Coast is at least as rigorous as in London, and attention should be given to the question of possible increase in defects on the voyage to England and during storage, as such increase would lead to discrepancies in assessment at each end of the journey.

* Abstracted from Part III of Professor C. Y. Shephard's Report on the Economics of Peasant Agriculture in the Gold Coast. See also *Tropical Agriculture*, Vol. XIII, No. 3, pp. 59-61.

Method of Inspection.

The present Gold Coast method of inspection is as follows: Upon notification of an intended shipment of cacao, an officer of the Department draws samples from a number of bags equal to twice the square root of the total. Each sample is obtained by inserting a cone-shaped sampling tool through the mesh of the bag, and just over a hundred beans are allowed to fall into the body of the sampler. For example, from a consignment of 1,600 bags, 80 such samples are taken, and these are spread on a flat surface and mixed for three minutes. The heap is divided into quarters, and, of these, two diagonally opposite are discarded. The remaining quarters are bulked and mixed by hand for one minute. The process is repeated until only 600 beans remain. Five samples of about 100 beans are taken by means of a shovel carefully slid under the heap, the cacao being drawn from different parts of the heap for each sample bag. These five bags constitute the final sample. A hundred beans are taken from each sample and arranged on a sampling board. Germinated beans are placed at the base of the board. Each bean is cut lengthwise through its largest section, half being replaced on the board with the cut surface upwards, and half discarded. A germinated bean is cut diagonally from just below the fat end to the thin end. Flat beans, classed as "other defects", are left uncut. Defective beans are removed and counted. Defects are averaged for the five samples, and recorded on the Certificate of Purity. The purity is ascertained by counting the number of sound beans, and not by subtracting the number of defects from 100. A single bean may have more than one defect, so that the number of defects may exceed the number of defective beans. A record is made of the number of beans which collectively weigh four ounces, and also of the number of beans required to fill a measure of 14 cubic inches. Finally the Certificate indicates whether the shipment complies with the United States Government's regulations, and under which Clauses it may be tendered on the Liverpool, London Cocoa Association, London Terminal and the New York Exchange, Markets.

There is good reason to believe that liability to error through mistakes in counting, falsification of Certificates, or substitution of inferior cacao after Certificates have been issued, is very low. Error due to the design of the sampling tools is similarly very slight, and it has been shown that the methods adopted give a reasonably accurate picture of the shipment as a whole.

Defect of the Present Method.

The principal defect of the present method is that it does not refer to each bag in the shipment. It is possible for a shipment with a recorded mean "purity" of 95 per cent. to have bags of 100 per cent. purity and others of 75 per cent. purity. The Certificate, when given, remains valid as long as the shipment remains intact, but loses its value when the bags are divided into two or more lots, as there is ample opportunity, when a shipment is divided into lots, for individual buyers to receive cacao above or below the purity stated on the Certificate, even though the examination has been carried out efficiently.

A Modified Method.

In place of this method, the following is suggested by which the Certificate can be made valid for each bag. The cacao, which must be commercially dry and free from foreign material, should be spread on a tarpaulin and thoroughly and evenly mixed. The Inspector should then take samples by hand from every section and reduce them after mixing and bulking to a convenient quantity, and finally carry out his analysis. If the merchant wishes to market his produce under a clause other than that stated on the Certificate he may recondition the cacao for re-examination by removal of defective beans by hand, by adding cacao of higher purity to raise the general level, or of lower purity to reduce the general level. After examination the cacao must be sifted through a sieve of standard mesh, bagged and sewn-up before the Inspector, who would then affix the official seals. Tampering with seals would be an offence. Storage under unsuitable conditions for long periods may cause deterioration in quality so that the Certificates should be given a limited currency, after which re-examination would be required. This method of inspection should cause no inconvenience if conducted at up-country buying centres, because merchants normally spread the cacao for drying before bagging it.

Advantages of Proposed Methods.

If this method is adopted, each bag of cacao, with a small allowance for imperfect mixing and errors of inspection, will be uniform throughout the consignment, and the Certificate will apply to each bag, and subdivision of any kind will leave each portion of the same quality as every other portion. In this case the exporter will be able to tender cacao safely under the appropriate market clause, and business operations will be generally facilitated. The departmental Certificates will acquire significance by being brought into line with standards recognised by the principal Markets. Up-country inspection is less likely to interfere with business than inspection at the port, but check-tests must be carried out at the ports to ensure that (1) previous inspection has been efficient, (2) inferior cacao has not been substituted after inspection, and (3) that the cacao had not deteriorated during storage. Every bag must conform to the standard indicated on the Certificate; any bag discovered to be below standard will indicate that the inspection has not been efficiently carried out, or that deterioration has occurred during storage or transportation. The inspector can be identified by the number of his seal, and the date of

inspection, and examination of the store and conditions during transport will enable responsibility to be allocated where due. Examination of seals will reveal any attempt to substitute inferior cacao. Up-country inspection will necessitate the employment of additional examiners, though it will not be possible to provide an inspector for every small buying station.

Examining centres should be registered and all matters pertaining to inspection should be considered by a standing committee appointed to advise the Director of Agriculture on this subject.

Cost and Introduction of the Scheme.

In Nigeria, a system of up-country inspection, with checking at ports, is maintained for 2/6 per ton, the cost being met by a cess on all cacao exported. In the Gold Coast, this figure should not be exceeded, except, perhaps, in the first few years, and the estimates already make provision for expense on inspection up-country for Co-operative Societies, and at the ports. Such a scheme of inspection as outlined should be introduced gradually to avoid dislocation of business, and to offer time for training of the required number of inspectors.

Further Modifications.

Further improvements could be effected in the nature of inspection: "purity" discussed above indicates the percentage of beans free from certain recognised commercial defects. It is not synonymous with quality. The only reference to degree of curing is that made in regard to slaty, or totally unfermented, beans. Size of the bean is also ignored. Both these factors are of importance to the manufacturer, and should be included in an assessment of quality. There is no clear line of distinction between under-fermented and adequately-fermented beans, and individual observers differ in their assessment of this factor. Gold Coast cacao is particularly bad in respect of fermentation, and this is mainly brought about by the reaping of unripe pods. Other factors contributing to the same condition are the fermentation of small quantities of cacao at a time, inefficient equipment, inadequate attention, and curtailment of the fermentation period. A small percentage of over-fermented beans occurs; this is mainly due to the fermentation of over-ripe beans.

A Modified Method of Grading.

The assessment of fermentation and size is not easy. Vilstrup has suggested that the value of Gold Coast cacao should be given by a single index, based upon the average weight, thickness, length, breadth, and purity of a sample of 100 beans. His method is simple and ingenious, but would involve so much labour as to render it unacceptable. It is possible that a simple method of grading could be introduced by considering the average weight and volume of samples. A heavy bean is usually large, and if its volume is great it will probably be well cured. A combination of these two attributes gives an indication of plumpness and fermentation sufficiently accurately for commercial purposes.

Suggested grades are: (1) Special grade. Every bag to conform to the following requirements: purity not less than 95 per cent.; moisture not more than 8 per cent.; the number of beans required to fill 14 cubic inches not to exceed 120, and the number of beans weighing 4 ozs., not to exceed 100. (2) First grade. Slate not to exceed 5 per cent.; defects other than slate not to exceed 5 per cent.; must be commercially dry; number of beans to fill 14 cubic inches not to exceed 130, and not more than 110 to weigh 4 ozs. (3) Second grade. Slate not more than 10 per cent.; defects other than slate not to exceed 10 per cent.; commercially dry. (4) Third grade. Slate not more than 15 per cent.; defects other than slate not more than 15 per cent., but purity to be not less than 80 per cent.; commercially dry. (5) Prohibited from export. Cacao with more than 15 per cent. slate, or more than 15 per cent. other defects, or a purity below 80 per cent. or not commercially dry.

If established, these grades would have the merit of conforming closely to existing commercial standards. The first grade could be tendered under Clause A, London and Liverpool, and satisfy the regulations of the United States Government. The second grade would be tenderable under "C" Clause, Liverpool. The principal changes are (1) the introduction of aspects of quality other than defects in the Special and First grades; (2) the establishment of a Special grade to cater for the increasing quantities of good quality cacao offered by the Co-operative Societies; (3) the prohibition of the export of cacao of a purity less than 80 per cent. or not commercially dry. Cacao prohibited from export would not be purchased by merchants, except, perhaps, at a low price for mixing with cacao of a higher purity. The price penalty would induce farmers to pay more attention to curing.

Raising of Grade Standards.

These grade standards should be raised progressively until all exports conform to the requirements of the Pure Food laws of the U.S.A., and the clauses of the principal Markets. At first, the Special grade could have the number of beans per 14 cu. ins. reduced to 110, and the number of beans per 4 ozs. to 95. The First grade could remain unaltered, and the Second grade should not include cacao in which either weevil or mould exceeded 5 per cent. The Third grade would not permit defects other than slate to exceed 12 per cent. and neither weevil nor mould to exceed 5 per cent. Cacao with slate exceeding 12 per cent., weevil or mould exceeding 5 per cent., all defects other than slate exceeding 15 per cent., or a purity below 80 per cent., or

not commercially dry, would be prohibited from export. In time the First grade would be governed by the same standards as the Special grade, the Second by those of the First as defined above, while the Third would take the standards of the Second as defined above. All cacao exported under these grades would be acceptable in the U.S.A. or under clauses A or C of Liverpool.

Advantages of Grading.

Grading furnishes an easy method of assessing the value of cacao and would probably lead to differential prices, which in turn would act as a powerful incentive to improvements in the preparation of cacao. Up-country inspection would ensure uniformity from bag to bag, and constancy of quality is known to be highly appreciated by manufacturers. Most factors of quality are not quantitative, but some of them can be reduced to terms of simple measurement needing very little time and inexpensive apparatus. The results of such examination, while not giving a precise measure of quality would be sufficiently accurate for commercial purposes.

R.G. F.

AGRICULTURE AND HEALTH.

The development of agriculture and the improvement of public health may appear to be two distinct aims with no relation the one to the other. But the suggestion has been made both by leading statesmen at an Assembly of the League of Nations and by scientists at a meeting of the British Association that the time has come for the two to advance hand in hand, by the securing of " the increased consumption of our own health-giving foodstuffs ".

Agriculture is hampered at the present time not by a shortage of labour or of land but by poor demand for her products. For instance, in Bermuda we could grow much larger crops and employ many more men on the farms if we knew that there was a good chance of our being able to sell the vegetables we grow. It is at the markets that the block occurs. Medical authorities, on the other hand, state that in many parts of the world the health of the people is undermined because inadequate quantities of fresh agricultural products are available for consumption. This condition is naturally worst in the cities and towns where people have not a chance of growing vegetables of their own and may not realise their need of them. It may be for instance that while we have vegetables lying in the market at Montreal for which there is no demand, there are people within five minutes' walk who would be enormously benefited if they could have a regular supply of fresh vegetables. They do not have it in many cases because they have not the money to buy it, and the farmer cannot give it away, but also in many cases because they do not appreciate the value of this type of food. One of the problems of the present day is to link up the producer and the consumer, so that the need of the one for an outlet for his produce may be met by the requirement of the other for a steady and inexpensive flow of fresh food.

Even in Bermuda where fresh vegetables are obtainable in quantity during much of the year, it is questionable whether fresh milk, fresh eggs, and fresh vegetables are adequately appreciated and sufficiently consumed. It seems probable that many residents in Bermuda and certainly many of our visitors, who in their home-towns may not find so ready a supply of fresh produce, would benefit by eating more eggs straight from the hen and vegetables fresh from the farm. It is satisfactory that increasing attempts are being made on the part of the growers to extend the season when supplies of fresh produce are available.

An article in *The Times*, reviewed in Horticultural Abstracts under the title " More Food from the Farmer " gives an indication of the convergent need of agriculture and public health.

" Evidence is brought to show the pronounced improvement in human health brought about by an increased consumption of the ' protective foods ', namely, milk, fresh vegetables, fruit and eggs. Many countries have recently initiated large scale experiments in nutritional feeding and the results obtained in every case are here described as ' startling '. It is shown too that in many cases where improved housing has involved a greater expenditure on rent and a consequent reduction in the family budget of the amount available for food, health has suffered rather than gained by the change. From this it is argued, and Governments are now becoming alive to the fact, that increased production rather than restriction of agricultural produce should be the aim. The prosperity of agriculture always reacts favourably on the prosperity of industry, and every effort should be made to extend agricultural markets. The farmer instinctively desires to farm well and produce to his utmost capacity and agricultural science has shown that the world can produce far larger yields without any considerable extension of area or increase of cost. It is emphasized, however, that it is not so much an increased consumption of easily preservable foods such as wheat, sugar, dairy products or meat that is required, as of the fresh perishable protective foods already mentioned. A concerted move by Governments to increase the consumption of food of this nature would be a certain way of restoring world trade and prosperity, and the deliberate association of the problems of agriculture and health presents a satisfactory line of advance ".

To borrow a striking metaphor from a representative of one of our Dominions it becomes increasingly evident that " Agriculture must be married to public health ".—(*Agricultural Bulletin*, Bermuda Department of Agriculture Vol. XV, No. 1, pp. 7-8, 1936.)

RESULTS OF MANURIAL EXPERIMENTS ON CACAO AT MARPER.

By F. J. Pound and J. de Verteuil.
(*Department of Agriculture, Trinidad and Tobago.*)

Introduction.

Marper Farm is a small cacao estate comprising 97 acres in the Plum District of the Ward of Turure in Trinidad. It was purchased by the Government in July 1929 for the purpose of studying methods of controlling Witchbroom Disease, and was placed under the supervisory control of Mr. J. de Verteuil. The estate consists of both undulating and flat land, with a variable soil. In flat areas subject to flooding there is a thin surface layer of alluvial silt.

The whole area suitable for experiments was divided up between :—

A.—Cultivation experiments.
B.—Manurial experiments.
C.—Spraying experiments.
D.—Other miscellaneous experiments.

This paper is concerned merely with the results of manurial experiments. The object of conducting fertiliser trials was to discover whether by adding suitable fertilisers to the soil, the trees would become more healthy, and consequently more resistant to disease or, failing that, to discover whether the increased crop following fertiliser application would be sufficient to pay for control of the disease.

Design of Experiments.

The eight trials consist of a series of randomised blocks, with four treatments in each block, and five replicates of blocks. Thus each block contains four, and each trial, 20 plots. The plan of the nitrogen trial is given below by way of illustration of the layout.

N_0	N_2	N_1	N_3
N_2	N_3	N_0	N_1
N_1	N_3	N_0	N_2
N_2	N_1	N_3	N_0
N_1	N_3	N_2	N_0

Each plot consists of five rows of five trees planted 13 feet apart, and thus occupies 1/10th acre. There were no guard rows left between plots or blocks, but in most cases drains served to sever cacao tree roots, and to prevent the robbing of fertiliser of one plot by trees of another.

Nature of Experiments.

The eight main trials were tests of the value of the following fertilisers :—

1. Lime on undulating land.
2. Sulphate of Ammonia.
3. Sulphate of Potash.
4. Superphosphate of Lime.
5. Sulphate of Ammonia and Sulphate of Potash.
6. Sulphate of Ammonia and Superphosphate of Lime.
7. Sulphate of Potash and Superphosphate of Lime.
8. Sulphate of Ammonia, Sulphate of Potash and Superphosphate of Lime.

Quantities of Fertilisers Used.

In each trial, except for lime, the four treatments consisted of :—

(*a*) Control.
(*b*) Single dose of fertiliser.
(*c*) Double dose of fertiliser.
(*d*) Triple dose of fertiliser.

Thus, in the case of the nitrogen trial, the treatments were :—

(*a*) Control, designated hereafter .... N_0
(*b*) 250 lb. Sulphate of Ammonia per acre, designated hereafter .... N_1
(*c*) 500 lb. Sulphate of Ammonia per acre, designated hereafter .... N_2
(*d*) 750 lb. Sulphate of Ammonia per acre, designated hereafter .... N_3

For Potash, the single dose was 100 lb. Sulphate of Potash per acre, and for Phosphate, the single dose of fertiliser was 325 lb. per acre.

Where there were combinations of two or more fertilisers in trials 5 to 8, the doses consisted of the combined doses of fertilisers in the single trials 2 to 4.

Thus for the Nitrogen and Potash trial, the four treatments were :—

(*a*) Control, designated N_0K_0
(*b*) Single dose, designated N_1K_1
(*c*) Double dose, designated N_2K_2
(*d*) Triple dose, designated N_3K_3

In the case of lime, the four treatments were :—

(*a*) Control, designated Ca_0
(*b*) Five tons pulverised limestone per acre, designated Ca_1
(*c*) 10 tons pulverised limestone per acre, designated Ca_2
(*d*) 20 tons pulverised limestone per acre, designated Ca_3

Times of Application.

The fertilisers were first applied during May and June of 1930, and crop records started with the new crop at the fall of the year. Every tree was labelled, and for the first three years pod records alone were taken. During the last two years (1933-34 and 1934-35), the weight of wet cacao per plot was also recorded with the pod number.

Fertilisers were applied a second time in May of 1932, with the exception of the pulverised limestone. In May 1934, there was a third application of Nitrogen, Potash and Phosphate, but only the single dose lime-treated plots received manure.

Thus for purposes of costs, each Nitrogen, Potash or Phosphate application must be reckoned as spread over two years. In the case of Lime, it so happens that the single dose treatment is the most valuable, and since the second application was given in 1934, the cost of each application must be shared by four years.

Results.

I. Lime on Undulating Land.

The yields from this experiment are set out below in Table I as the average number of pods per tree for each treatment during the five seasons.

Table I.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
Control ..	37	18	24	19	31	129
5 tons per acre ..	42	26	33	25	43	169
10 tons per acre ..	46	28	33	23	41	171
20 tons per acre ..	43	23	31	23	40	160
Total ..	168	95	121	90	155	

It will be noticed that the seasonal effect during the course of the experiment was towards an alternation of good and poor years. This large variance is noticeable throughout the whole set of experiments, demonstrating that in cacao the beneficial effects of manures are largely secondary to the vagaries of climate.

The second point of importance in Table I is the fact that plots receiving 20 tons of Lime per acre give a smaller yield than those receiving lighter applications. During the first two years of the experiment, the plots treated with ten tons of Lime per acre gave the highest returns. In the third year, the five tons per acre plots overtook those which received ten tons, and in the last two years actually passed them in yield.

Table II shows the final analysis of variance for this experiment. The variance due to seasons shows up very significantly as was anticipated. The variance due to treatments is sufficiently large to be significant, and the difference between treatment totals would occur by chance less than once in 100 trials.

The Standard Error of the difference between treatment means is 1.478 pods ; hence a difference of 2.956 between any two treatment means is statistically significant.

It follows that the result of adding five tons of Lime per acre gives a very large increase in yield, and that ten tons of Lime per acre gives no additional benefit in the long run ; any additional benefit shown at the start being offset by the end of five years.

The first liming was made to last for four years, so that for purposes of calculation of costs, the application of five tons of Lime per acre is equivalent to $1\frac{1}{4}$ tons per acre per annum.

The increased yield resulting from this application of Lime was an average of eight pods per tree or 2,000 pods per acre per annum.

Weight of Wet Cacao.

The wet cacao was weighed only during the last two years of the experiment. The yields for those two years (Table III) show that there is no additional benefit to be obtained from adding more than five tons of Lime per acre, viz. :

Table III.

Treatment.	Mean No. of pods per tree	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao.
		lb.	lb.	
Ca_0	50	10.6	4.24	11.8
Ca_1	68	14.2	5.68	12.0
Ca_2	64	14.4	5.76	11.1
Ca_3	63	13.2	5.28	11.9

Table II.

Analysis of Variance of Limed Plots. (Number of Pods.)

Due to	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within blocks	20	815	40.8		
Between Seasons	4	6,110	1527.5		
Between Treatments	3	1,135	378.3	2.969	
Interaction : Seasons and Treatments ..	12	125			1.316
Interaction : Blocks and Treatments ..	60 (72)	1,844 (1,969)	27.3	1.653	
Total	99	10,029			

For P=.01, a difference of 0.665 is significant.

The Analysis of Variance of wet cacao, Table IV, shows that the addition of five tons of Lime per acre gives a statistically significant increased yield of wet cacao, as would be expected.

Table IV.

1st Part Analysis of Variance of Wet Cacao.

Due to	D. F.	Sum of Squares.	Variance.	½ $\log_e$.	Difference.
Between Blocks ..	4	50	12.5		
Between Treatments	3	46	15.3	1.3639	.6464
Error ..	12	50	4.2	.7175	
Total ..	19	146			

P=0.05. Difference to be significant must exceed 0.625, hence this result would occur by chance less than once in twenty trials. The increase of crop from five tons of Lime per acre

=1.8 lb. per tree.

=450 lb. per acre.

=180 lb. dry cacao per acre.

Value at five cents per lb.; $9.00 per acre per annum.

From a small test experiment on the vega lands at Marper, the increase in yield from liming at ten tons per acre was of the same order, and there was no apparent effect on pod value.

Costs.

Lime was delivered at Marper Estate at a cost not exceeding $6.60 per ton.

Cost of five tons per acre	.... $33.00
Cost of weeding and heaping débris	1.60
Cost of heading lime and applying	2.60
Cost of lightly forking soil	1.70
Cost of respreading mulch	.80
Total Cost	.... $39.70
Cost per annum	.... $9.93

Thus with the present mixture of cacao trees, many of which are genetically and physically slow to respond to any cultural treatment, there is no financial benefit to be expected immediately from merely liming Marper soils. It is suspected, however, that the real effect of Lime on the soil is permanent, so that in the long run the increased crop would repay the costly applications of Lime.

It should be pointed out that, on heavy clay soils which have a much greater acidity than the undulating Marper soils, several planters claim very large increases of yield resulting from lime applications. It is only recently that critical experiments to test this assertion have been started.

II. Nitrogen.

The yields for the nitrogen experiment are set out in Table V as the mean number of pods per tree for each treatment during each of the five years of the experiment.

Table V.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
Control ..	31	21	22	18	25	117
250 lb. per acre ..	31	19	19	14	23	106
500 lb. per acre ..	32	18	20	12	25	107
750 lb. per acre ..	33	19	27	16	26	121
Total ..	127	77	88	60	99	

It is obvious from a perusal of the yields that *there has been no beneficial effect* resulting from the addition of Sulphate of Ammonia.

This is demonstrated in the Analysis of Variance (Table VI), of the mean yields over the five-year period.

Table VI.

Analysis of Variance.

Due to	D.F.	Sum of Squares.	Variance.
Between Blocks ..	4	220	55
Between Treatments	3	22	7
Error	12	400	333
Total	19	642	

Hence it appears that no benefit will immediately accrue from the addition of Sulphate of Ammonia to the soils of Marper. The yields during the last two years as lb. of wet cacao bear this out. (Table VII.)

Table VII.

Pods and Wet Cacao—1933-35.

Treatment.	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao.
		lb.	lb.	
N_0	43	8.8	3.52	12.2
N_1	37	7.8	3.12	11.8
N_2	37	8.6	3.44	10.8
N_3	42	8.8	3.52	11.9

III. Potash.

The average numbers of pods per tree for each treatment during the five years of the experiment are set out in Table VIII.

Table VIII.

Treatment.	1930–31.	1931–32.	1932–33.	1933–34.	1934–35.	Total.
Control ..	25	13	17	12	21	88
100 lb. per acre..	28	15	20	16	29	108
200 lb. per acre..	30	15	19	18	29	111
300 lb. per acre..	39	18	27	18	32	134
Total ..	122	61	83	64	111	

It will be noticed that the increases in yield are proportional to the amounts of fertilizer applied. The alternate good and poor seasons show up again in these results. The final Analysis of Variance of yields is given in Table IX.

Seasons and Treatments in this case show significant differences in yield which would occur by chance only in a fraction of one per cent. of cases. (Table IX.)

The Standard Error of the difference between treatment means is one, hence a difference of two pods between any two treatment means would occur by chance less than once in 100 trials.

It follows that the application of 100 lb. of Sulphate of Potash per acre is *beneficial* on the Marper soils, and the application of three times this quantity gives a further significant increase in yield.

The increased yield in the latter case
=9.2 pods per tree per annum.
=2,300 pods per acre.

Weight of Wet Cacao.

The total yield of wet cacao for the two recorded years is set out below. (Table X.)

Table X.

Pods and Wet Cacao—1933-35.

Treatment.	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao.
		lb.	lb.	
K_0	33	6.6	2.64	12.5
K_1	45	9.2	3.68	12.2
K_2	47	9.6	3.84	12.2
K_3	50	10.2	4.08	12.2

The Analysis of Variance shows that this beneficial effect of Potash is exceedingly significant and would occur by chance less than once in 100 trials. (Table XI.)

Table XI.

1st Part Analysis of Variance—Potash Wet Cacao.

Due to	D. F.	Sum of Squares	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Between Blocks ..	4	32	8.0		
Between Treatments	3	38	12.7	1.271	1.068
Error ..	12	18	1.5	0.203	
Total ..	19	88			

For P=0.01, a difference of 0.892 is sufficient for significance.

The increase of crop resulting from the application of 300 lb. of Potash per acre
=1.8 lb. per tree per annum.
=450 lb. per acre.
=180 lb. dry cacao per acre.
Value at five cents per lb.=$9.00 per annum.

Table IX.

Analysis of Variance of Potash Plots. (Number of Pods.)

Due to.	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within Blocks	20	710	35.5		
Between Seasons	4	3,770	842.3		
Between Treatments	3	1,065	355.0	2.936	
Interaction : Seasons and Treatments ..	12	280			1,681
Interaction : Blocks and Treatments ..	60 (72)	602 (882)	12.3	1.255	
Total	99	6,437			

Costs.

Potassium Sulphate was delivered at Marper at a price not exceeding $60.00 per ton.

Application of 300 lb. per acre cost	$8.04
Cost of application, heaping débris, &c.	3.40 per acre
Total cost each application	$11.44 do.

Since fertilisers are applied every two years, the cost per annum=$5.72 per acre.

Thus for an outlay of $5.72 per acre, there has resulted an increased crop valued at the present day (five cents per lb.) at $9.00.

Profit per acre—$3.28 per annum.

(On the same basis the profit from 100 lb. Sulphate of Potash per acre would be $1.36.) Hence it should prove remunerative to apply Potassium Sulphate at the rate of 300 lb. per acre to the Marper soils.

In practice, fertilisers can be applied much more cheaply. Where the field has been recently cleaned, applications at the rate of four lb. of fertiliser per tree have been made at a total labour cost of 30 cents per acre. This includes weighing, heading to field and spreading.

IV. Phosphate.

The yields of pods for the different Phosphate treatments are set out in Table XII below for each year as mean yields per tree.

Table XII.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
Control ..	30	15	21	19	25	110
325 lb. per acre ..	36	17	26	21	31	131
650 lb. per acre ..	39	18	26	18	29	130
975 lb. per acre ..	34	19	28	19	31	131
Total ..	139	69	101	77	116	

The increase of yield appears to be similar for each of the three quantities of Superphosphate added, and is of the order of 20 per cent. From a knowledge of intrinsic tree to tree variation, an increase of less than 30 per cent. would hardly be expected to be statistically significant. The Analysis of Variance shows, however, that the increase in this case is consistent enough over the five year period of the experiment to be deemed significant. (Table XIII.)

The seasonal variation is again very significant.

The increase in number of pods resulting from applications of Superphosphate at Marper is not borne out so strikingly by the weight of wet cacao. (Table XIV.)

Table XIV.

Pods and Wet Cacao—1933-35.

Treatment.	Mean No. of pods per tree	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao.
		lb.	lb.	
P_0 ..	44	9.6	3.84	11.4
P_1 ..	52	10.4	4.16	12.4
P_2 ..	47	10.2	4.08	11.5
P_3 ..	50	10.4	4.16	12.0

Hence there has been no visible beneficial effect of Phosphate on bean size.

The increase in pod yields is surprisingly low when compared with some of the increases of 50 per cent. and even 100 per cent. obtained by McDonald on clay soils.

McDonald finds, however, that the greatest response to Superphosphate comes from the calcareous clay soils, and so this result, taken in conjunction with the need for Lime shown in the Lime experiments, suggests that the first need of the Marper soils, and possibly others, is a correction of the Lime deficiencies.

Costs.

Superphosphate can be delivered at Marper Estate at approximately $25.00 per ton.

Cost of 325 lb. per acre....	$3.63
Cost of applying, &c.	3.40
Total	$7.03

Table XIII.

Final Analysis of Variance. (Pods; Phosphate.)

Due to	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within Blocks	20	1,745	87.3		
Between Seasons	4	4,085	1021.0		
Between Treatments	3	320	106.7	2.335	
Interaction: Seasons and Treatments ..	12	220			0.687
	72	1,941	27	1.648	
Interaction: Blocks and Treatments ..	60	1,721			
Total	99	8,091			

For P=0.01, difference to be significant must exceed 0.665. Hence the result would occur by chance less than once in 100 trials.

Each application lasts two years—cost per annum=$3.52. Increase of crop=1,050 pods per acre per annum, average over five years.

During the 2-year period, 1933-35—
Pods produced .... =24,133
Wet cacao produced .... =5,099 lb.
Dry cacao .... =2,040 lb.
=11.8 pods per lb. dry cacao.

Value of increase in crop at five cents per lb. dry cacao, $4.45.

Profit per acre from application of 325 lb. Superphosphate=$0.93.

Hence on Marper soils, Superphosphate applied at the rate of 325 lb. per acre should give an increased profit from cacao at present prices of nearly one dollar per acre.

V. Nitrogen and Phosphate.

The yields of pods for the combined applications of Nitrogen and Phosphate are set out in Table XV as mean number of pods per tree for each treatment during the five years of the experiment.

Table XV.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
N_0+P_0 ..	22	14	18	11	22	87
N_1+P_1 ..	31	17	23	11	25	107
N_2+P_2 ..	30	16	25	13	30	114
N_3+P_3 ..	27	18	27	13	27	112
Total ..	110	65	93	48	104	

The biennial variation in yields is again very apparent. There appears to be an increase in yield resulting from the treatments applied, since the N_2P_2 plots give an average of more than 30 per cent. increase of crop over the control.

The final Analysis of Variance shows that this benefit is consistent enough to be significant, and the result would occur by chance less than once in 100 trials. (Table XVI.)

The Standard Error of the difference between treatment means is 1.59, hence a difference of 3.18 pods per tree is significant. Thus double and triple doses of fertiliser give no further significant increase in yield over normal applications.

The weight of wet cacao obtained during the last two years of the experiment bears out the increases in yield shown by the number of pods reaped. (Table XVII.)

Table XVII.

Pods and Wet Cacao—1933-35.

Treatment.	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods per lb. dry cacao.
		lb.	lb.	
N_0P_0 ..	33	7.0	2.8	11.7
N_1P_1 ..	36	8.0	3.2	11.3
N_2P_2 ..	43	9.4	3.76	11.4
N_3P_3 ..	50	9.0	3.6	13.9

It cannot be claimed from these figures that the fertilisers have had any appreciable effect on the size of beans. In the case of the triple dose treatment, there were probably several trees which bore very small pods in one or more of the plots.

Costs.

Sulphate of Ammonia can be delivered at a cost of approximately $40.00 per ton.

Cost of 250 lb. Sulphate of Ammonia	$4.46	per acre.
Cost of 325 lb. Superphosphate	3.63	do.
Cost of applying, approximately	5.00	do.
Total	$13.09	do.

or $6.55 per acre per annum.

Increase of crop=4 pods per tree=1,000 per acre, average per annum over five years.

Table XVI.

Analysis of Variance. (Pods; N+P.)

Due to	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within Blocks	20	368	18.4		
Between Seasons	4	3,520	880.0		
Between Treatments	3	460	153.3	2.516	
Interaction: Seasons and Treatments ..	12	240			0.789
	72	2,276	31.6	1.727	
Interaction: Blocks and Treatments ..	60	2,036			
Total	99	6,624			

During the 2-year period, 1933-35, this experiment produced :—

19,092 pods, and 4,213 lb. wet cacao,
=1,685 lb. dry cacao.

∴ Mean number of pods per lb. dry cacao=11.3. Value of 1,000 pods increase of crop at five cents per lb. dry cacao=$4.42 per annum.

Hence there was a net loss of $2.13 per acre per annum from the combined Nitrogen and Phosphate treatments.

Thus the addition of Sulphate of Ammonia has had no effect whatsoever, since the increased returns from this experiment are equal to those from the plain Phosphate experiment above.

VI. Nitrogen and Potash.

In this experiment, the fertiliser applied was a combination of Potash, which proves on its own very beneficial to Marper cacao, and Nitrogen appears to have no benefit at all.

The yields in pods are set out in Table XVIII in the usual manner.

Table XVIII.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
Control ..	29	15	21	12	22	999
N_1K_1	27	15	22	15	26	105
N_2K_2	30	14	24	13	28	109
N_3K_3	30	17	24	12	26	109
Total ..	116	61	91	52	102	

It is very noticeable that the differences in yields for the different treatments are very slight, demonstrating that, if in the Potash experiment the results were real, then the effect of Nitrogen applied with the Potash is to annul the beneficial effect of the latter.

The Analysis of Variance for the average yields over the five-year period shows that the treatment variance is very low, and not likely to be significant. (Table XIX.)

Table XIX.

Analysis of Variance—(Pods ; N. K.)

Due to	D.F.	Sum of Squares.	Variance.
Between Blocks ..	4	95	24
Be ween Treatments	3	12	4
Error ..	12	375	31
Total ..	19	482	

The yields of wet cacao support this result as the table below shows. (Table XX.)

Table XX.

Pods and Wet Cacao—1933-35.

Treatment.	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao
		lb.	lb.	
N_0K_0 ..	34	7.4	2.96	11.5
N_1K_1 ..	41	8.8	3.52	11.6
N_2K_2 ..	41	8.6	3.44	11.9
N_3K_3 ..	38	8.2	3.28	11.6

Hence on Marper soils, Sulphate of Ammonia seems to be detrimental rather than beneficial to the cacao crop. It is worth recording here that, from unpublished results of another experiment, the Nitrogen applications proved detrimental at the start, but the effect on the health and vigour of the trees finally erased the detrimental effect. It appears however, that, given strong and healthy cacao trees, the need is for Potash, Lime and Phosphate, rather than for Nitrogen.

VII. Potash and Phosphate.

The yield in mean pods per tree for the four treatments during each year of the experiment is set out below in Table XXI.

Table XXI.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
Control ..	40	26	29	26	32	153
K_1P_1	38	24	31	23	32	148
K_2P_2	43	27	38	26	39	173
K_3P_3	40	27	38	27	44	176
Total ..	161	104	136	102	147	

Between treatment totals, the triple dosed plots show an average increase in yield of 15 per cent. over the controls. This is much less than was obtained from Potash alone, so that the effect of Phosphate seems to have been to depress the beneficial effect shown by Potash previously.

The Analysis of Variance demonstrates that, although the effect of the treatments is relatively small, there is a significant increase in yield in the case of the double and triple dosed plots. (Table XXII.)

Table XXII.

Analysis of Variance. (Pods; P.K.)

Due to	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within Blocks	20	1,126	56.2		
Between Seasons	4	3,435	858.8		
Between Treatments	3	595	198.3	2.645	
Interaction: Seasons and Treatments ..	12	385			0.859
	72	2,560	35.6	1.786	
Interaction: Blocks and Treatments ..	60	2,175			
Total	99	7,716			

The Standard Error of the difference between treatment means is 1.69, hence a mean difference of 3.38 pods per tree would occur by chance less than once in 100 trials. The triple dose gives no additional advantage over the double dose.

The yield of wet cacao during the 2-year period, 1933-35, shows only a slight benefit from the treatments as the table below demonstrates. (Table XXIII.)

Table XXIII.

Pods and Wet Cacao—1933-35.

Treatment	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods per lb. dry cacao.
		lb.	lb.	
K_0P_0 ..	58	12.4	4.96	11.7
K_1P_1 ..	55	11.4	4.56	12.1
K_2P_2 ..	65	13.4	5.36	12.1
K_3P_3 ..	71	14.2	5.68	12.4

Costs.

The costs of fertilisers and applying, work out as follows: —

Potash at 200 lb. per acre	$5.36
Phosphate at 650 lb. per acre	7.26
Cost of applying, approximately	5.00
Total	$17.62

=$8.81 per acre per annum.

Increase of crop = four pods per tree as an average over the 5-year period

= 1,000 pods per acre per annum.

During the period, 1933-35, the experiment produced: —

31,089 pods and 6,380 lb. wet cacao.

= 2,552 lb. dry cacao.

∴ Mean number of pods per lb. dry cacao = 12.6

Value of increased crop at five cents per lb. =$4.00.

Hence, in spite of increased yields, there was a loss of $4.81 per acre per annum from the treatment.

This is a very surprising result, considering that both Potash and Phosphate alone are very *beneficial.*

In an experiment at River Estate, there was a well marked positive interaction between Potash and Phosphate. The reason for this anomaly is being investigated.

VIII. Nitrogen, Potash and Phosphate.

The pod yields over the 5-year period are set out below in the usual manner. (Table XXIV.)

Table XXIV.

Treatment.	1930-31.	1931-32.	1932-33.	1933-34.	1934-35.	Total.
$N_0P_0K_0$ ..	37	25	29	22	31	144
$N_1P_1K_1$ ..	43	24	35	24	35	161
$N_2P_2K_2$ ..	48	29	38	25	41	181
$N_3P_3K_3$ ..	48	28	38	23	41	178
Total ..	176	106	140	94	148	

In each season, the highest yield occurs in the double dosed plots. Hence this appears to be the optimum requirement for this treatment. The increase in yield shown by double dosed plots over controls is of the order of 25 per cent., which is greater than that shown by Phosphate alone, and less than the increase shown by Potash alone. The Analysis of Variance demonstrates that the increase of yield is quite significant and would occur by chance less than once in 100 trials. (Table XXV.)

Table XXV.

Analysis of Variance. (Pods ; N.P.K.)

Due to	D. F.	Sum of Squares.	Variance.	$\frac{1}{2}\log_e$ Variance.	Difference.
Within Blocks	20	1,625	81.3		
Between Seasons	4	5,465	1366.3		
Between Treatments	3	875	291.7	2 838	
Interaction : Seasons and Treatments ..	12 } 72	275 } 2,649	36.8	1.803	1.035
Interaction : Blocks and Treatments ..	60	2,374			
Total	99	10,614			

For P=.01, a difference of 0.665 is significant. The Standard Error of the difference between treatment means is 1.716. Hence a difference of 3.43 pods between mean yields can be judged significant. Thus the $N_1P_1K_1$ treatment is barely significant, but the yields from the double and triple doses are very significantly better than those from the controls.

The yield of wet cacao during the last two years of the experiment bears out the increase of pod numbers. This is illustrated in Table XXVI.

Table XXVI.

Treatment.	Mean No. of pods per tree.	Mean Weight wet cacao per tree.	Mean Weight dry cacao per tree.	Pods lb. dry cacao
		lb.	lb.	
$N_0P_0K_0$ ..	53	11.4	4.56	11.6
$N_1P_1K_1$ ..	59	13.0	5.20	11.3
$N_2P_2K_2$ ..	66	5.36	5.36	12.3
$N_3P_3K_3$ ..	64	13.2	5.28	12.1

There is again no visible effect of the fertiliser treatments on pod value.

Costs.

This is the most costly of all the experiments. Taking the double dose treatment as giving the highest increase over controls, the costs work out as follows :—

500 lb. Sulphate of Ammonia	$8.92	per acre
650 lb. Superphosphate	7.26	do.
200 lb. Sulphate of Potash	5.36	do.
Cost of applying	6.50	do.
	$28.04	

=$14.02 per acre per annum.

The increased yield is an average of 7.4 pods per tree per annum over the 5-year period. This equals an increase of 1,850 pods per acre per annum. During the period, 1933-35, from this experiment there were 30,525 pods reaped.

The weight of wet cacao from these pods

=6,322 lb.

=2,529 lb. dry cacao.

∴ Mean number of pods per lb. dry cacao=12.1.
Value : 1,850 pods at five cents per lb.=$7.64.

Hence there is a net loss on the treatment of $6.38 per acre per annum.

Summary.

The most beneficial fertiliser in this series is undoubtedly *potash*, applied at the rate of 300 lb. of Potassium Sulphate per acre. There is a net profit in this case of $3.28 per acre per annum.

Lime is also needed, and applications at the rate of five tons per acre give an increased yield of nearly 40 per cent. The cost of the treatment is greater than the increased revenue from the cacao at present prices.

Phosphate gives a smaller actual increase in yield than Lime, but a more profitable one. The profit from an application of 325 lb. per acre appears to be approximately $1.00 per acre per annum.

Nitrogen gives *no benefit at all*. When applied with either Potash or Phosphate, it tends to decrease rather than to increase the beneficial effect of the other fertilisers.

Potash and Phosphate together did not give the great increase in yield anticipated from the increases obtained when each was applied separately. This may be due entirely to a lack of balance between actual quantities of Potash and Phosphate applied. While K_2P_2 gives no real benefit, K_2P_1 might conceivably be beneficial.

LEAF CURL OF TOBACCO IN SOUTHERN NIGERIA.

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By J. West, B.S.A. (McGill), A.I.C.T.A.
(*Agricultural Department, Nigeria.*)

Introduction.

In Southern Nigeria tobacco is a minor native crop, which is grown, for local consumption only, either in compound land adjoining the villages, or in small plots scattered through the field crops. The native methods of cultivation have been described by Thornton (1). During the past two years, however, commercial enterprise, in co-operation with the Department of Agriculture has endeavoured to induce the native farmers, in parts of the South Western Provinces, and at Maigana in the Northern Provinces, to grow a Virginian type of tobacco on a larger scale. This paper contains the results of some investigations concerning Leaf Curl, which is the most important disease that has appeared in the South.

Previous History.

Leaf Curl is a virus disease of tobacco. Its distribution, cause and symptoms have been fully described by Storey (2). He states that the disease appears to be present in most parts of Africa where tobacco is grown. Recently, it was found in the Gold Coast Colony (3).

Leaf Curl was first recorded in Nigeria in 1923 on some experimental tobacco plots at Ilorin, though it was not then specifically named. Jones and Mason (4), when describing their work on Leaf Curl of cotton, stated that they frequently found similar symptoms on tobacco plants in the South Western Provinces of Oyo and Abeokuta. An isolated case was reported from Maigana in 1935, but the disease appears to be very rare in the North. Recent observations suggest that, while Leaf Curl can be found on native grown tobacco in the South, the amount of infection is usually very small.

Symptoms.

Specimens of the Nigerian form of Leaf Curl were sent to Professor S. F. Ashby, of the Imperial Mycological Institute, who replied that there could be no doubt that the disease was the same as that existing in East Africa. Storey (2) says that "... The character that distinguishes this disease from all other causes of leaf curling is the presence of the outgrowths from the veins on the lower surface of the leaf. The leaf of a suspected plant should be held up to the light; if the smaller veins show up a decidedly darker green than the lamina, the diagnosis is certain ..." This greening of the smaller veins is typical of Nigerian Leaf Curl (Plate II, Fig. 1). In older leaves the veins are frequently thickened, and have occasionally cup-like outgrowths on the lower surfaces. These symptoms are accompanied by a downward curling of the leaf margins and a general distortion of the entire leaves (Plate I, Fig. 2). When infection has occurred in the seedling stage, the plants appear never to develop properly. Plants infected at later stages will have healthy lower leaves and may reach maturity. The flowers produced by such plants show very prominently the greening of the smaller veins in the calyx segments.

Leaf Curl in 1935.

In 1934, a healthy late sown tobacco crop was grown in the Ipetu area (*see* Map). In 1935, two successive crops were attempted in both the Ipetu and Oshogbo areas. The first crop was planted out in early June and the second at the more normal time in August and early September. Leaf Curl appeared in the first crop nurseries and it spread rapidly there and, later, in the field. Eventually, infection became so general that this crop was almost entirely ruined. The second crop was grown in the same districts and often in adjacent plots, and was therefore subjected to abundant inoculation, both in the nurseries and in the field. Consequently the rate of infection was high, but it did not reach the magnitude of that in the first crop, and the September planted plots were less affected than those planted in August.

In the same year only a late crop was tried in the Ogbomosho area. The nurseries were sown in June and transplanting began early in August. This crop was generally very healthy and the rate of infection averaged under one per cent.

Incidence of White Fly.

Storey (6) and Hopkins (5) have shown that a species of white fly (*Aleurodidae*) is the vector of Leaf Curl in East Africa. Observations were made on tobacco white fly during the 1935 season. In the Ogbomosho area the white fly population increased steadily until towards the end of July. Its numbers then diminished rapidly, and by the end of August they had become, and remained thereafter, extremely low. The nurseries were sown during June and were heavily infested with white fly in July, but infected seedlings were found in only two beds. It is of interest that the particular nursery in which these two beds occurred had along one border an infected shrub, which is suspected of being an alternative host of Leaf Curl. This point will be mentioned again. In the Oshogbo and Ipetu areas similar records were obtained regarding the periodic incidence of tobacco white fly. Ipetu is situated in an area with a rather heavier rainfall, and here white fly still occurred sporadically up till the end of September.

Where infected plants existed in a plot, it was generally observed that they had a number of white flies on them, whilst near-by healthy plants had few or none. This applied more particularly to the late sown crop, and it is possible that conditions in the latter part of the season are not favourable to the migration of this species of white fly.

LEAF CURL OF TOBACCO IN SOUTHERN NIGERIA.

PLATE I.

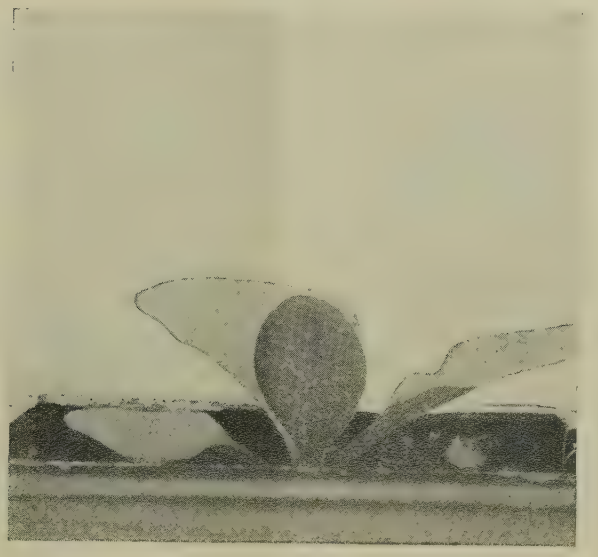


FIG. 1.—*Healthy uninoculated tobacco plant.*

FIG. 2.—*Infected tobacco plant four weeks after inoculation with white fly*

LEAF CURL OF TOBACCO IN SOUTHERN NIGERIA.

PLATE II.

FIG 1.— *Under surfaces of diseased and healthy tobacco leaves.*

FIG. 2.— *Under surfaces of diseased and healthy leaves of (Vernonia amygdalina ?).*

Photographs taken by transmitted light. In both cases the diseased leaves show a greening of the small veins.

PLATE III.

FIG. 1.—*Showing tobacco plants under lamp glasses, and paper cap used to make white fly settle after inoculation.*

Inoculation Experiments.

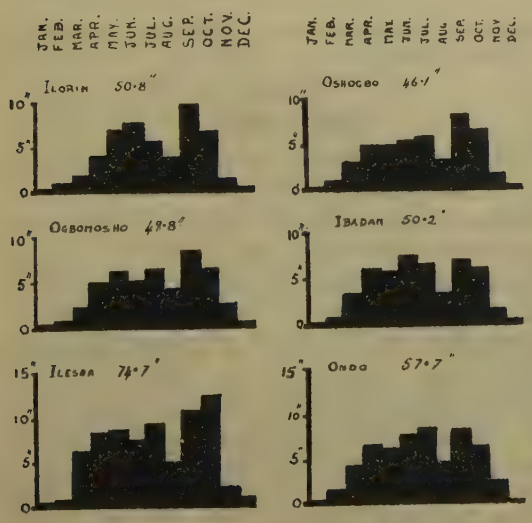
In co-operation with Mr. F. D. Golding, Senior Entomologist of this Department, a series of inoculation experiments were carried out, using the white fly from tobacco as the probable vector. The technique described by Hopkins (*loc. cit.*) was largely followed.

Tobacco seedlings of the Virginian type in question were raised in an insect-proof muslin cage. When large enough, they were transplanted singly to four-gallon petrol tins. These tins were filled with soil which, though not sterilized, had had no tobacco growing in it for at least ten years previously. Each plant was covered with a lamp glass, the upper end of which was covered with fine muslin (Plate III, Fig. 1). There were 12 tins in this experiment, and five were inoculated with white fly taken from infected tobacco plants which had been brought down from Oshogbo and replanted at Ibadan. Four of the tins were inoculated with 25 adult white flies each, and the fifth with 50. The white flies were introduced beneath the lamp glasses in the early morning, and it was found necessary to cover the glasses with brown paper caps for 24 hours to induce them to settle on the tobacco seedlings. This method had previously been employed by Hopkins (*loc. cit.*). Each inoculated seedling showed a greening of the veins in the youngest leaf in from 11 to 14 days. The number of white flies used did not seem to influence the time of appearance of the first symptoms. After one month each seedling had developed the symptoms typical of Leaf Curl infection (Plate I, Fig. 2), and at the end of the experiment, was covered with white flies. The seven un-inoculated plants remained healthy throughout this period.

Attempts to bring about the infection of tomato and chillie seedlings and cuttings of *Vernonia* (*amygdalina* ?) and *V. Tenoreana*, using the same technique, gave negative results, although they were cut back and re-inoculated two or three times. The white flies bred slowly on the tomato seedlings but did not seem to do so on the other hosts.

TABLE I.

GRAPHS SHOWING MONTHLY RAINFALLS



Alternative Hosts.

In East Africa, Storey (2) suspects a species of *Vernonia* (*Compositae*), amongst other weeds, as being an alternative host for the Leaf Curl virus. He adds, however, that " . . . the identity of the viruses causing Leaf Curl in the range of weed plants that show typical symptoms must for the present be regarded as doubtful . . . ". Mossop (7) gives a list of plants on which the tobacco white fly has been found in Southern Rhodesia, which includes *Vernonia* sp.

In the South Western Provinces *Vernonia* (*amygdalina* ?) occurs fairly commonly in the bush, and in certain areas it is planted in the fields as a support for yam vines. Cases have been found in which these shrubs bore leaves showing the greening of the veins and the production of enations which are symptoms typical of Leaf Curl in tobacco (Plate II, Fig. 2). Such infected bushes are not common, and it is very rarely that any white flies are found on them. As already mentioned, on the border of the one nursery at Ogbomosho which had many infected tobacco seedlings, there was an infected bush of *Vernonia*. This may have provided the original source of infection in this nursery. As, however, the attempt to inoculate healthy *Vernonia* cuttings with tobacco Leaf Curl gave negative results, the position remains obscure.

Native Tobacco Culture.

The normal method employed by the native farmer in the South Western Provinces is to transplant his tobacco seedlings from the nursery in August. This allows the plants to obtain the full benefit of the late rains and to ripen off with the advent of the dry season.

The average monthly distribution and the total annual rainfall of the areas described are shown in Table I. The rains usually commence towards

NIGERIA . Sketch map of South Western Provinces .

the end of March and become heavy in June and July. A break normally occurs in August, when the weather is frequently cool and cloudy. The rains become heavy again in September and then tail off rapidly after October.

The native farmers recognize Leaf Curl as a form of disease, and they maintain that it is brought on by heavy rainfall during the growth of the tobacco.

Control of Leaf Curl.

Methods for the control of Leaf Curl have been discussed by Storey (2), Hopkins (*loc. cit.*) and Mossop (*loc. cit.*). Their main point is the avoidance of *infected* white fly. They advise the complete destruction of all tobacco plants at the end of the crop. They have found that volunteer plants carrying the Leaf Curl virus can arise from old roots in the field and from seedlings left over in the discarded nurseries, and that these are the main sources of original infection for the next season's crop. Storey (2) has also found at Amani that tobacco can be grown during the winter months without becoming infected with Leaf Curl, possibly because of the almost complete disappearance of tobacco white fly at that time of the year.

In the South Western Provinces the native method of growing tobacco in the late rains appears to provide a sound control measure against Leaf Curl infection. By the time the seedlings are transplanted, the white fly population has begun to decline rapidly. Thus, even if infected plants are taken from the nursery, the spread of the disease from these to healthy plants in the field will be small; and if all infected seedlings are discarded, the chances of a diseased crop are still further reduced. Infection is therefore only possible to a serious extent in the nursery, and, under present conditions, this does not seem to occur. It is possible that since tobacco has heretofore been grown only as a late crop on a small scale, the potential sources for original infection each season are very limited. Tobacco has been grown in the South Western Provinces over a long period, however, and if there are alternative hosts of a perennial habit for Leaf Curl, it might be supposed that a common source of the virus would have been built up in the course of time.

Lewin has remarked (8) that in the South Western Provinces, " . . . the indigenous cottons are highly susceptible to Leaf Curl during the early rains but that this susceptibility diminishes as the normal time of planting (*i.e.* the beginning of July) approaches . . ." It is of interest that a similar state of affairs appears to hold true for Leaf Curl of tobacco.

If, however, a more intensive cultivation of tobacco develops in these areas, then the precautionary methods advocated for East Africa will, probably, have to be employed. Large scale tobacco crops in native rotations would probably necessitate a great deal more care as regards the destruction of the plant remains at the end of each season. Furthermore, the search for any alternative hosts of tobacco Leaf Curl will have to be continued. At the same time, it is quite possible that the seasonal conditions which exist in the South Western Provinces are such that late planting, according to native practice, will prove to be the major control measure.

Summary.

1. This paper describes the results of some investigations concerning Leaf Curl of tobacco in Southern Nigeria.

2. The symptoms of this disease are described and illustrated.

3. The relationship between the incidence of the disease, the white fly vector and seasonal conditions is discussed.

4. Various precautions to be adopted for the control of Leaf Curl are noted.

Acknowledgments.

I wish to acknowledge with thanks the assistance given by Professor S. F. Ashby, of the Imperial Mycological Institute, Kew. I am indebted to Mr. O. T. Faulkner, C.M.G., Director of Agriculture for much helpful literary criticism, and to Mr. F. D. Golding, Senior Entomologist, whose co-operation made possible the inoculation experiments described in this paper. I also wish to record my appreciation of the help given me by members of the staff of the British American Tobacco Company.

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A SOIL MAP OF EAST AFRICA.

THE publication of a provisional soil map of East Africa* has been awaited with a great deal of interest by those who have followed the development during recent years of the Amani Research Station, and of the various departments of agriculture in East Africa. The investigation of tropical soils by British workers has only just commenced, and much leeway remains to be recovered if they would keep abreast of their American colleagues who have made notable contributions to the science of tropical soils, not only in the Caribbean region and other parts of the New World, but also even in Africa itself. The appearance in 1923 of " The Soils of Africa ", compiled by the late Dr. C. F. Marbut, Chief of the United States Soil Survey Department, and issued by the American Geographical Society, has greatly stimulated the study of the distribution and modes of formation of tropical soils in general, and doubtless that of East African soils in particular, by the enthusiastic band of collaborators whose names are attached to this new publication.

The first annual report of the Amani Research Station for the year 1928-29, presented a research programme drawn up by the Director (Mr. W. Nowell), in which the systematic study of East African soils was especially urged, and the inauguration of a soil survey strongly recommended. It is indeed a very creditable performance that such rapid progress has been made in these projects as to render possible the publication of a provisional soil map within eight years of these decisions. A tentative scheme of soil classification for the four northern British Dependencies of East Africa, namely Kenya, Uganda, Tanganyika and Zanzibar was agreed upon at the first conference of soil chemists, held at Amani in May, 1932, and the compilation of the necessary data was accordingly undertaken by participating officers at their respective headquarters. Sufficient progress had been made by August, 1934, to justify the decision reached at the second conference of soil chemists to publish the results, and to coordinate them into a single soil map, under the general editorial direction of Mr. G. Milne, Soil Chemist at Amani. The final drawing of the map was made by Milne in London during March to July, 1935; it was subsequently printed in colours at the Ordnance Survey Office, Southampton, in 1936. The scale is one in two millions, or approximately one inch to 32 miles. The area covered lies between longitudes 29° and 41° east of Greenwich, and latitudes 11°45′ south of the equator and 4° north, or some 685,000 square miles of country. A great part of the map is uncoloured, indicating the absence of reliable soil data, the only admissible basis for mapping a district agreed upon by the contributors being " some direct record of the properties of its soils ".

* A Provisional Soil Map of East Africa, with Explanatory Memoir, by G. Milne, in collaboration with V. A. Beckley, G. H. Gethin Jones, W. S. Martin, G. Griffith and L. W. Raymond, 1936. Obtainable from The East African Agricultural Research Station, Amani, Tanganyika, or from the Crown Agents for the Colonies, 4, Millbank, London, S.W.1. Price, 5s. post free.

Classification of East African Soil-Types.

The following list gives the provisional names and brief descriptions of the main soil-types so far identified and mapped by the East African workers.

(1) *Desert Soils*, (2) *Saline Soils*, including alkali soils, (3) *Plains Soils*, pale-coloured soils, occupying semi-arid flat country carrying a thorn and grass vegetation, (4) *Black or Grey Clays*, known locally as " black cotton soils ", (5) *Mottled Clays* (limited mainly to Zanzibar and Pemba), (6) *Red Earths*, derived from gneisses, granites, intrusive volcanic rocks, shales and sandstones, and moderately leached but acidic, though not laterised, (7) *Laterised Red Earths*, derived from similar rocks, but much more highly leached, and occupying mountain grasslands and evergreen forest lands, (8) *Plateau Soils*, pale-coloured soils of poorly-drained areas, (9) *Podsolised Soils*, of cool, high-altitude rain forests and grasslands, showing accumulated acidic humus and bleached subsoil, and (10) various *lithological types* of soil, whose features depend on the nature of the parent rocks, which have not suffered much alteration by weathering. They include volcanic ash, pumice and tuff soils, coastal loose sands, alluvial soils and residual soils occurring in pockets on limestone. These main soil-types and their variants are mapped in distinctive coloured hatchings—Desert Soils, purple; Plains Soils, green; Black or Grey Clays, blue; Red Earths, red and orange; Plateau Soils, brown, and lithological types, yellow.

A striking feature of the map is the vertical striping in different colours covering large areas, and indicating that two or more soil-types here occur in conjunction. Such association of soils is an expression of repeated alternations of particular topographical features or variations in local geology occurring over considerable stretches of land. Thus, within the greater part of Uganda, the land surface is undulating or hummocky, and differences in drainage conditions occur on the dry hill-crests and in the wet hollows. The type of soil occupying the crests differs materially from that occurring in the swampy bottoms, but the sequence is repeated throughout the whole area with a high degree of regularity. A typical traverse shows this sequence of changing soil profile, whose appearance and other properties are obviously mainly due to varying topography. Instead of mapping the soils as one type, the expedient method of mapping the area in strips of two alternating colours has ingeniously been adopted.

In other regions, such as parts of Central Tanganyika, geological factors have imposed additional complications on the topographical factor, and more than two distinctive soil-types are involved in the association. It has been proposed by the East African soil surveyors to employ the term " *catena* " or " *catenary complex* " for such soil successions, and the term would appear to be very apt. It implies the " hanging together ", like the links of a chain (Latin, catena), of the different members of the complex within the soil association.

Two other kinds of soil associations have also been recognised in East Africa, and have been indicated on the soil map, though no distinctive names have yet been assigned to them. In these, drainage conditions due to topography are not the main factor, but rather the differing characters of the parent soil-forming rocks. Thus, localised occurrences of superficial loose sands and alluvial deposits may give rise to patches of useful agricultural soil within an area whose soil-type is otherwise different and agriculturally undeveloped. Furthermore, the occurrence of a pattern of geological outcrops, such as occurs along parts of the east coastal region of Africa where a wide range of sedimentary rock types are exposed, presents varying lithological features which have profoundly influenced the distribution of soil-types. Such areas can only be described in general terms, and their soils cannot accurately be mapped on a small scale. Hence the notation used on the map is a series of scattered discs, coloured according to the recorded types of soils which comprise the different lithological complexes.

Factors Determining Soil-Type in East Africa.

Certain outstanding conclusions have been reached regarding the modes of formation and origin of the East African soils. Evidently no single physical factor has exerted supreme directing influence on soil-type over the region as a whole. In certain areas, climate or topography or kind of parent material may specifically and individually have exerted chief influence in the formation of the characteristic soil, but only at the extremes of its range, and only when the effects of the other factors are subsidiary or negligible. Thus, the soils occurring over areas of well-distributed high rainfall (60 to 80 inches a year), all conform to the *Laterised Red Earth* type, (sometimes showing podsolisation of the surface layers), regardless of the kind of parent rock, which may be either acidic or basic igneous rock, metamorphic rock, sandstone or limestone. The rainy districts are mountainous or undulating, and natural free drainage conditions occur throughout. Weathering and leaching processes are rapid in operation, and plant growth is accordingly very luxuriant. The resulting type of soil may thus truly be described as a " climatic " type, for all other soil-forming factors here have exerted lesser effects. Where surface relief is extreme, even in areas of high rainfall, the dominance of climate is no longer evident, its importance becoming subsidiary to topography. The bottom lands receive run-off water, but their drainage is deficient. Consequently, *Black or Grey Clay* soils develop, and these differ greatly from the soils of the hill slopes and hill crests. Finally, in some areas, the geological factor is the dominating influence, as for example, in the case of soils formed from loose volcanic ash, unconsolidated sands and clays, and recent alluvium. Such soil-types are lithological types, and their individuality tends to increase with diminishing rainfall.

An interesting fact concerning some of the soil-types of East Africa is the evident lack of relationship between their features and properties and the present-day climate. Thus, certain Red Earths of extensive distribution occur outside the limits of what is usually regarded as the proper climatic domain of such soils, the prevailing conditions being now semi-arid. In order to explain these occurrences, it has been assumed that the climate has changed in comparatively recent times, but that the newly imposed conditions have not operated long enough to have obliterated the impress of the former conditions on the character of the soil profile. These effects, persisting from past times, have complicated the general pattern of the East African soil map, and have somewhat obscured the correlations that might be sought between the soil-types and the present-day climatic and topographic factors. The incompleteness of the map renders it difficult to decide at this early stage whether or no " soil zones ", which are so characteristic of the soil maps of Russia and of North America, will eventually be discernible in East Africa, even in spite of these local complexities.

Land Classification and the Soil Map.

Geographical soil maps, such as the provisional soil map of East Africa, do not aim at expressing detailed relationships between soil conditions and the suitability of the land for crop production and agricultural settlement. The soil features and properties on which the map is based rather aim at a scientific description of the main types of soil regarded as natural objects, though certain of them are fundamentally significant in soil utilisation. A great many more kinds of soil exist in East Africa than can be mapped on a scale as small as one in two million, but it is hoped that, in due course, detailed soil surveys in important localities will be systematically undertaken in the near future.

The Soils of the East African Dependencies.

Part II of the explanatory memoir accompanying the provisional soil map of East Africa deals with the characteristic soil-types developed in the four separate dependencies. Some of the main points are summarised below.

(1) Kenya Colony and Protectorate.

Substantial information for this country is available only for the central highlands lying between latitudes 1°N. and 2°S. of the equator, including the floor of the great Rift Valley and parts of the north-eastern coast of Lake Victoria. According to the description presented by V. A. Beckley and G. H. Gethin Jones, the most wide-spread soil-type of the highlands of Kenya is *Laterised Red Earths*. East of the Rift Valley, and between Nairobi and Mount Kenya, the parent rocks from which the Red Earths have been derived are porous volcanic tuffs and acidic lavas. The soil profile is very deep (over 15 feet), and uniformly bright red in colour. The soil is friable though clayey, and the reaction is acidic (pH 5 to 6). The Red Earths are the most productive soils of Kenya. West of the Rift Valley, and north-westwards to Mount Elgon, the Red Earths have been derived from massive lava, and are browner in colour and shallower in depth. They sometimes occur here in catenary association with non-calcareous *Black or Grey Clays*, and their subsoils frequently contain concretionary ironstone or "murram". Near Lake Victoria, the Red Earths have been derived from gneiss and granite. They are pink in colour, sandy in texture, and the profile is shallow. Northwards, the Red Earths are non-laterised, variable in colour and much heavier.

The floor of the Rift Valley in Kenya is mainly occupied by non-calcareous, variable, grey, brown and pink soils, derived from erosion-products of rocks bordering the escarpments, with local additions of volcanic ash. These soils have been classified as *Plains Soils*. Calcareous representatives of this type, resembling the Chestnut Earth of Russia, occur in the semi-arid plains of south-east Kenya. They are pale red in colour, and their subsoils contain a well-marked calcareous pan. Another calcareous sub-group occurs west of Mount Kenya under a semi-humid climate. It is a deep, friable, fawn-coloured soil, containing columnar lime accumulations in the deeper layers of the profile.

A large area of upland flat country in Kenya is occupied by *Black and Grey Clays*, somewhat resembling the Black Cotton Soil of India. They comprise a large group whose members range from calcareous to non-calcareous soils, exhibiting various features depending on the predominance of one or other of the three factors, climate, parent rock, and drainage. The calcareous black clays occur in the drier flatter districts. They shrink and crack greatly during dry weather and swell in the rains. The surface humic soil, falling down the cracks, becomes incorporated with the subsoil, producing a uniform profile. Calcium carbonate has accumulated near the weathering parent material, often in nodular masses ("kunkar"). Under increasingly wetter climates the soil-types are greyer in colour, less calcareous and more acidic or distinctly podsolic in character at the extreme end of the series, especially where drainage is impeded.

The coastal belt of Kenya presents a series of soils ranging from loose sands to swampy black or grey clays, with sandy red earths occupying the ridges. Inland, the arid "nyika" plateau is covered with a red soil probably belonging to the *Plains Soils* type. The large delta of the Tana River is occupied by a range of alluvial soils, mostly of tidal origin.

(2) Uganda Protectorate.

According to the account by W. S. Martin and G. Griffith, the formation of the soils of Uganda has chiefly been decided by topography, which in turn depends on the geological structure of the country. The greater part of Uganda is an elevated peneplain dissected by recent river systems. The altitude varies from 3,000 to 5,000 feet. The country is bounded on the north-east and the west by broad Rift Valleys. At the edges of these valleys occur great volcanic mountains, rising to heights of nearly 17,000 feet. The western Rift Valley contains large lakes (Lakes Albert, Edward and George), and most of the Eastern Province is occupied by Lake Kioga, which originated by the confinement of the waters of a great ramifying river system by the damming of its westerly outlet by earth movements. This lake actually consists of vast papyrus swamps with comparatively little open water.

The greater part of Uganda is underlain either by Archaean rocks, comprising gneisses, granites, and quartzites, together with newer granites, or by ancient sedimentary rocks of the Karagwe-Ankolean System, each presenting its own distinctive type of topography.

The principal soil-type of Uganda is *Unlaterised Red Earths*, occurring over the peneplain plateau. In the valleys and hollows between the flat-topped hills, occur non-calcareous *Black and Grey Clays* or swamp-soils in catenary association with the Red Earths. The catena derived from the Archaean metamorphic and igneous rocks has been differentiated from the catena derived from the sedimentary Karagwe-Ankolean shales. In addition to the main catenary soil-types, three other soil-types have been identified and mapped, namely, black *Volcanic Soils*, derived from recent volcanic ash, *Calcareous Black Clays and Sandy Clays*, occurring along the floor of the western Rift Valley and derived from fossiliferous sedimentary rocks, and fertile *Unlaterised Red Earths*, derived from volcanic rocks occurring on the western slopes of Mount Elgon.

(3) Tanganyika Territory.

The soils of this vast region lying to the south of Kenya and Uganda comprise numerous distinctive types which are described in some detail by G. Milne in the explanatory memoir accompanying the East African soil map.

The low-lying coastal belt of varying width is occupied by four kinds of soil, namely (*a*) *Tidal Muds*, carrying a mangrove swamp flora, (*b*) *Red Clays*, derived from raised banks of coral limestone,

(*c*) *Red Sandy Clays*, occupying broad low ridges favoured for Sisal growing, and (*d*) a complex of pale-coloured *Loose Sands* passing into grey or black sandy clays where poor drainage conditions obtain.

Inland to the coastal belt occurs a dissected low plateau, consisting of Cretaceous and Jurassic sedimentary rocks, whose derived soils owe their distinguishing features to the nature of the parent materials. The marls and soft limestones give rise to poorly-drained *Dark-Grey Clays* carrying a bush savannah vegetation. The harder limestones, sandstones, sands and shales produce *Red Soils* of variable depth and fertility, carrying forest or scrub, depending on rainfall. These sedimentary soil-types are represented on the map by the " disc " notation.

Further west, mountainous country prevails, whose rocks are mainly gneisses belonging to the Archaean Basement Complex. Leading up to the mountain escarpments, north and south of Tanga, is a broad peneplain which separates the Cretaceous plateau from the interior highlands. The climate of the peneplain is semi-arid, and its soils have been provisionally classified as *Plains Soils* and *Plateau Soils*, though little exact information about them has yet been accumulated.

The mountainous regions nearest the coast are covered by rain forest or by secondary bush, bracken scrub or grassland. The soils are typical *Laterised Red Earths*, formed under a rainfall of 60 to 80 inches, a temperature of 20°C., and conditions of free drainage.

Near the north end of Lake Nyasa in the extreme south-west of Tanganyika, and along the western shore of Lake Victoria in the north of the Protectorate, occur other areas of Red Earths occupying high mountainous country of large rainfall. The parent rocks include gneisses, granites, volcanic lavas, sandstones and shales. At altitudes above 6,000 feet, the Red Earths of these highlands, carrying rain forest or bracken, are podsolised; their surface layers are grey-brown or yellow-brown in colour, and contain considerable accumulations of black acidic humus, with slightly bleached layers below. At the eastern foot of certain of the escarpments occur broad plains that receive drainage water from the mountains. Their soils are heavy black clays interspersed with fertile alluvial soils, detrital soils, loose sands and Plains Soils, represented on the soil map as catenas and other associations by the stripe and the disc notation.

All but the wettest parts of the mountain regions are covered by *Unlaterised Red Earths*, sometimes associated with non-calcareous *Black or Grey Clays* (mostly grey) forming a catena where badly-drained bottom lands occur.

The country interior to the eastward-facing mountain ranges comprises vast elevated plateaux, whose soils have not yet been much investigated, although they cover a large proportion of the total area of Tanganyika. The soils here developed seem not to be very closely related to present-day climatic conditions, and have proved difficult to classify exactly. They conform in some instances to the *Plains Soils* type, associated in the lower-lying sites with the *Black or Grey Clays* soil-type. For the most part, the characteristic soil appears to be an intermediate type between well-drained *Red Earths* and the *Plains Soils-Black Clays* complex. It is generally underlain by concretionary ironstone (" murram "), indicating intermittent under-drainage. Its principal vegetation is deciduous open savannah forest (" miombo ") or xerophytic bush with Baobab, replaced in areas where Black or Grey Clays predominate by an Acacia thorn-bush savannah vegetation.

The remaining soil-types of Tanganyika include *Volcanic Ash and Tuff Soils*, occurring on the lower slopes of the Meru Mountains, and over the Serengeti Plain lying further west across the Rift Valley. Soils derived from volcanic ash and pumice also occur, often superimposed on older soils, on the slopes of the highlands between Lake Nyasa and Lake Rukwa in the south of Tanganyika. Certain inland drainage basins surrounding large lakes contain *Saline Soils*, and the lower course of the great Rufiji River presents *Alluvial Soils* and *Tidal Deltas Soils*. The only true *Desert Soils* occur near the summits of Kilimanjaro and Meru within a rocky alpine zone of elevation about 18,000 feet.

(4) Zanzibar Protectorate (Zanzibar and Pemba).

The distribution of the main soils of these two islands is shown in large-scale inset maps, and their chief features are described by L. W. Raymond in the explanatory memoir. The climate of Zanzibar and Pemba is moist and hot (60 and 78 inches annual rainfall respectively, and temperature 80°F). It shows well-marked wet and dry seasons. The geology and soils of the two islands differ considerably, the rocks of Pemba being the older, but in each case, the rock-types are sedimentary, including hard coral limestones, marls, calcareous and non-calcareous sands and clays.

The most widespread soil-type of Zanzibar is a highly humic soil occurring in pockets on flat coral limestone, and inclining to a *Red Earth* type. It is not extensively cultivated, and is mostly covered by bush and grass. The soil pockets are utilised for growing annual crops under shifting cultivation in the neighbourhood of villages. In Pemba, this kind of Red Earth soil occurs only as a narrow east-coastal strip. In both islands, *Sandy Red Earths* form the most valuable agricultural soil, and are utilized for the growing of cloves. This soil-type is not appreciably laterised, though often very acidic. Its colour varies from deep red to yellow-brown. Distributed irregularly through the Red Earth areas occurs a distinctive soil-type designated *Mottled Clays*, also utilised for clove growing.

Its subsoil is a variegated tenacious clay, though the upper soil resembles Red Earth. The profile is evidently immature, but genetically the soil may be classed as Red Earth. The Mottled Clays are represented by the " disc " notation on the maps. They are more extensive in Pemba.

The *Black or Grey Clays* soil-type occurs conspicuously in Pemba, where it occupies swampy valley bottoms. It is mapped as a catena with the *Red Earth-Mottled Clays* complex. *Black or Grey Clays* are not extensive in Zanzibar, and their occurrences have not been mapped, except in the north, where a related Black Clay covers the summits and slopes of broad calcareous ridges.

Finally, considerable areas of *Loose Sands* occur in both islands, where they are utilised for growing coconuts and food-crops, and a peculiar shallow *Grey Laterised Clay* occupies swamp forest on coral limestone in the south of Zanzibar. On the whole, the soils of the islands are difficult to classify under the broad groups represented on the mainland; their main features seem to have been decided chiefly by the nature of the varied parent rocks, and by differences in topography.

F. HARDY.

REVIEWS.

HUMUS; ORIGIN, CHEMICAL COMPOSITION AND IMPORTANCE IN NATURE.

By S. A. Waksman, *Bailliere, Tindall & Cox*, London, 1936. pp. 494, price 30s.

This book has been written by a recognised American authority on soil organic matter and its natural transformations; it brings together in readable and attractive form much information which is scattered throughout the literature of Soil Science, and otherwise difficult to procure.

According to the author, " The book is an attempt to tell the story of humus, its origin from plant and animal residues, its chemical composition, its physical properties, its importance in nature, especially in soil processes and in plant growth, and finally its decomposition. Humus is treated here as a natural body, produced universally in nature, wherever plant or animal residues are undergoing decomposition. Without denying the rôle of purely chemical reactions in the formation and transformation of humus, especially those of oxidation and reduction, hydrolysis and polymerization, it should be recognised that the primary agents in the formation and transformation of humus are the micro-organisms; by overlooking their functions, the earlier chemists failed to understand the origin and significance of humus, in spite of the many years of effort, from the beginnings of organic chemistry until recent times. The soil, compost, peat bog, and ocean are living systems, where the organic constituents are continuously modified by numerous processes brought about by micro-organisms which live in these systems and reproduce, utilize energy and give off heat, decompose organic substances, and construct new complexes. Humus and living microorganisms are connected by numerous invisible ties, which must be appreciated in order to understand the origin and nature of humus."

Over thirteen hundred references are cited in the bibliography and considered in the text. This compilation alone must have entailed a great amount of study, but the author does not merely quote the views of other authorities. His own brilliant work in this field, extending over a period of fifteen years, entitles him to criticise and to judge the findings of others, and to interpret authoritatively the main conclusions. Although the principal point of view from which the book has been written is that of the microbiologist, Dr. Waksman has emphasised the chemical and physical aspects of this vast subject, and has clearly indicated the bearing of the accumulated information on the theory and practice of agriculture. Among the topics considered are the following:—the rôle of humus in plant nutrition; humidification of organic matter in composts, manures and soils; origin and chemical nature of humus; methods of determination of humus; humus in forest soils, heath soils, mineral soils, peat and coal; physical properties of humus; utilisation of humus for agricultural and industrial purposes.

Students of agriculture and soils owe a great debt of gratutide to Dr. Waksman for putting before them in available form the results of practically all the important researches in humus that have occupied the attention of a host of investigators since the beginning of the seventeenth century. No other book contains such a mine of information on this subject, and no agricultural nor soils library is complete without a copy of this book on its shelves.

F. H.

* * *

THE S.A. SUGAR YEAR BOOK AND DIRECTORY 1936.

Compiled and edited by H. O. Andrews, M.J.I. Durban, 1935, price. 5s.

We have had the pleasure of reviewing the previous annual editions of this Year Book, and the one for 1936 is in every way up to standard. It is pleasing to have on hand such a compact directory of such an important industry. The work is profusely illustrated with excellent photographs showing the machinery used in, and the construction work connected with the Natal Sugar industry. We would wish to repeat our former suggestion that other countries follow the example of producing an annual compilation of this type.

J. G. D.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Sulphitation. *E. W. Layton.*

The advent of P.O.J. 2878 cane and other cane varieties containing juice of a similar character has presented a problem in clarification that may be of minor importance in some localities but of very serious consequences in others. Those factories which were unable to maintain continuity of operation at a normal grinding rate by some modification of regular practice or by the use of phosphoric acid in some form, were forced to resort to the use of sulphur dioxide as the only means of obtaining a juice of acceptable clarity within a reasonable settling time.

The procedure followed at Hutchinson Sugar Plantation Company is sulphuring cold, prior to the addition of lime. The sulphur dioxide is produced in rotary sulphur burners, which are now accepted as standard equipment. Calcium sulphite is more soluble in cold than in hot juice, and cold sulphitation is likely to cause a heavier deposit of scale in the juice heaters; in cases where this deposit forces discontinuous operation because of cleaning operations, it is better to employ hot sulphitation to diminish the solubility of the lime sulphite, especially if much lime and heavy sulphitation is required. (No temperatures are specified.)

In some cases, it is found that a passable clarity, 3.0 cm. Kopke, could be attained with as high a reaction as pH 4.5, while at other times, under apparently similar conditions the same reaction produced a juice of less than 2.0 cm. clarity; but if the reaction pH 4.0 is maintained, the clarity of the juice is always acceptable, never less than 3.5 cm. Kopke. The pH 4.0 is therefore accepted as a standard at the author's factory. However, the optimum reaction is found to vary at different factories and to a greater or less degree with each different type and variety of cane.

Aside from giving a fast settling juice, one of the major benefits of sulphitation is a less viscous, faster boiling massecuite, and the reduced viscosity is further reflected in better crystallization; sugar colour is improved. There is a saving of time and steam, a reduced gravity purity of the final molasses and a possible increase in centrifugal capacity through the elimination of extra boiling. The disadvantages are: an excessive scale on the juice heaters which if eliminated by hot sulphitation may require additional heater equipment. An increase in purity between mixed juice and syrup not as great as in lime defecation, and the extra cost of the treatment, which varies with the degree of sulphitation required and the quality ratio of the cane, and may range between 30 and 15 cents per ton of sugar obtained.—(*Facts About Sugar*, Vol. 31, No. 7, pp. 265-266, 1936.)

Effect of Nitrogen on Cane Yield and Juice Quality. *U. K. Das and A. H. Cornelison.*

Three blocks of H 109 cane were planted, and fertilized with 133, 266 and 645 lbs. of nitrogen per acre. All blocks received the same amounts of phosphate and potash fertilizer, and the same irrigation treatment. Beginning at four months and continuing at two-month intervals all blocks were sampled and analysed and growth measurements were made.

In summarizing the result it is noted that the higher the application of nitrogen, the greater the tiller production, the greater the number of joints formed, the higher the rate of cane growth, and the greater the tonnage of cane. However, with the highest applications of nitrogen, mortality of cane may be so great as to produce less cane than with a moderately large application of nitrogen.

The more nitrogen applied, the greater the succulence (*i.e.* the water content of the plants); it is suggested that the increased water content dilutes the juice and probably determines whether the sugar manufactured by the plants will be stored as sucrose or with a larger proportion of glucose. Hence the concentration of the sucrose in the plant will be lower, and of glucose the reverse will be the case. The moderately high applications gave the highest amount of sucrose; the increased tonnage from the high application was largely offset by the poorer quality.

The greater the application to the soil, the greater the percentage of nitrogen in the cane. The electrical conductivity of the juice increases with increased applications of nitrogen, indicating that nitrogen stimulates the absorption of other soil constituents. Electrical conductivity and sucrose content of the juice appear to be inversely related.—(*Inter. Sugar Journal*, Vol. XXXVIII. No. 451, p. 270, 1936.)

* * *

Composition of Superphosphates.

The results of chemical analysis and X-ray diffraction analysis, each method complementing the other, show: (1) that hydrated monocalcium phosphate and anhydrous calcium sulphate are the predominant constituents of ordinary superphosphate prepared commercially; and (2) that either hydrated or anhydrous monocalcium phosphate predominates in commercial double superphosphate. — (*Inter. Sugar Journal*, Vol. XXXVIII, No. 451, p. 269, 1936.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Manganese and Plant Growth.

Manganese is now recognised as an essential element for normal plant growth, and most soils contain sufficient of it in an available form to supply the needs of all vegetation. There are certain soils, however, mainly reclaimed swamp soils and soils with a very high calcium carbonate content, in which manganese is either not present in sufficient quantities, or not in an available enough form, to support the growth of certain crops. Characteristic diseases then result, of which the best known are the grey speck disease of oats, a disease of beet in Holland, chlorosis of spinach on Long Island and diseases of tomatoes and other crops on the Everglade soils of Florida, although in the last case deficiency of copper appears to be concerned as well as of manganese. The availability of the manganese in the soil is influenced to some extent by weather conditions and by cultural practices. In general, dry conditions aggravate the diseases, and also manurial treatments, such as liming, which tend to make the soil more alkaline. In Denmark a formula is now used, known as the " manganese value " (*Steenbjerg. Trans. Third Int. Congr. Soil Sci.*, Oxford, 1935,) which is based on a determination of the exchangeable manganese by leaching with magnesium nitrate, and on a factor which is a measure of the energy displayed by the soil colloids in keeping the exchangeable manganese. It is advocated that the manganese value of the soil should always be determined before liming, especially in the case of sandy soils, so that a calculation can be made of the largest allowable increase in pH which would not entail danger of grey speck disease. In the same report, Gerretsen claims that the symptoms of manganese deficiency are largely the result of the absorption of toxic products from bacteria which multiply more profusely on the roots of manganese-deficient plants.—(*Nature*, Vol. CXXXVIII, No. 3480 p. 68, 1936.)

* * *

Plant Cover as Protection against Soil Erosion.

This topic is dealt with very fully by Mr. J. Kramer and Prof. J. E. Weaver of the University of Nebraska, in Bulletin 12 of the Conservation Department of the University, recently published. The controlling of wastage of land through soil erosion is one of the major economic problems in America, and was brought forcibly into the public interest by the great dust storms of 1935. The authors have standardised a technique in which undisturbed samples of field soil of reasonable size can be lifted, with the crops they bear uninjured, and then exposed to erosion by a stream of water directed on to the surface from a hydrant. Numerous data obtained by these methods are assembled and discussed, but the striking general result is the very great protection against rain erosion provided by the above-ground portions of the plant compared with the root system alone. The authors conclude that the character of the crop is a principal factor in erosion control, the effect with plant cover intact exceeding that of underground parts alone from 3 to 7 times. Maximum protection was afforded by winter wheat and sorgo ; oats and alfalfa were less effective. Among pasture plants, well-established Hungarian brome grass was found most effective. The authors naturally conclude that the weakening of grasses by over-grazing, trampling and injudicious burning may contribute materially to soil erosion.—(*Nature, Vol.* CXXXVII, No. 3477, p. 1038, 1936.)

* * *

Non-Poisonous Insecticides.

Attracted by the large and growing market in the United States and elsewhere for non-poisonous insecticide materials, agriculturists the world over are directing more attention to the cultivation of plants yielding such substances, according to the Commerce Department's Chemical Division. In some countries the movement is being furthered by Government aid and encouragement, particularly in Yugoslavia, Bulgaria, Brazil, and Peru.

Pyrethrum flower heads obtained from certain species of chrysanthemum are the most important insecticide, although cube and derris and other rotenone-bearing roots are rapidly growing in favour with American manufacturers, but as yet importations are small. Pyrethrum, used extensively in fly sprays, is a common wild plant of Yugoslavia but the flowers entering commerce are almost wholly cultivated in that country as well as in Japan, and to a lesser extent in Kenya Colony, East Africa, France, Italy, and a few other countries.

Japan, which is the world's principal source for pyrethrum, produced approximately 24,400,000 pounds last year, 15,000,000 pounds of the total coming from mainland districts and the balance from the Island of Hokkaido. Stimulated by a large harvest and low prices, Japan's pyrethrum exports reached the peak of approximately 17 million pounds in 1935, more than 15.5 million pounds of which were shipped directly to the United States. Japanese trade opinion forecasts a heavy supply of pyrethrum flowers during the current year, owing to an extension of approximately 2,000 acres in new plantings and heavy stocks in the United States.—(*Ind. & Eng. Chem. News Edit.*, Vol. XIV, No. 11, p. 225, 1936.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observation is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR. — Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign. s.	d.	*Preferential.* s.	d.
25th June	4	6¾	8	3¾
2nd July	4	3¾	8	0¾
9th July	4	5¼	8	2¼
16th July	4	5¼	8	2½
23rd July	4	5½	8	2½
30th July	4	5½	8	2½
6th August	4	6	8	3
13th August	4	5½	8	2¼
(15th *August*, 1935)	4	4½	8	1½

The general tone of the market has remained steady. Holders have shown no desire to liquidate and buyers are in no anxiety regarding supplies. There has been little activity in the future market.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel*
26th June	7.18	9.25
3rd July	7.18	9.68
10th July	7.58	10.14
17th July	7.47	10.44
24th July	7.33	—
31st July	7.10	—
7th August	7.02	—
14th August	6.92	—
(16*th August*, 1935)	6.56	8.18

American quotations have weakened but the technical position remains strong. Demand continues active and consumption is larger than for a long time. Movements and price will depend largely upon weather advices from the American belt. Egyptian prices have hardened owing to speculative operations consequent on the report that the Egyptian crop, and especially Sakel cotton, would be smaller than anticipated. Prices of Sea Island have remained firm and there has been a limited business at 18½*d.* to 20*d.* per lb.

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed continues very slow of sale, value unchanged 32*s.* 6*d.* to 35*s.* Distilled also unchanged with holders asking 22*s.* 6*d.* *Lime Juice.*—There is still no demand for concentrated and raw remains quiet and unchanged at 2*s.* to 2*s.* 6*d.* according to quality.—*West India Committee Circular*, 30th July, 1936.)

COCOA.—During the past month the cocoa market has been quiet and manufacturers, with one or two exceptions, were generally inclined to hold back, showing an apparent unwillingness to pay present prices pending the rapidly approaching heavier arrivals from Bahia and the marketing of the new African crops. New crop Accra is offered at 28*s.* 3*d.* c.i.f. and locally $11.00 per fanega is paid for Plantation cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COFFEE.—Brazil markets have been firmer on news that the Institute intends to destroy 30 per cent. of the new crop. Superior Santos is quoted at 43*s.* to 45*s.* per cwt. The Brazilian crop is estimated at the higher figure of 22,500,000 bags. Blue Mountain Jamaica realised up to 197*s.* for bold size.

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows :—

	Pence per lb.
24th June	7 1-2
1st July	7 1-2
8th July	7 3-4
15th July	7 13-16
22nd July	7 3-4
29th July	7 3-4
5th August	7 5-8
12th August	7 9-16
(14*th August*, 1935)	5 11-16

United Kingdom stocks have declined for the twentieth consecutive week giving a total reduction of 39,880 tons. Total consumption in the U.S.A. for the six months January to June 1936, amounted to 282,968 tons against 255,815 tons last year. This exceeds the previous record of 269,308 tons for the corresponding period of 1929. Consumption for June 1936, was 52,635 tons or 2,024 per working day, both records. Several producing companies have sold part of their output for 1937 at prices in the neighbourhood of 8*d.* per lb. c.i.f.

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BANANAS.—The trade in bananas continues very good considering the quantity of competitive soft fruits on the market. Jamaicas are £19 5*s.* per ton. During the fortnight ended 11th July, 979,278 bunches were imported into the United Kingdom from the following sources :—Jamaica, 638,194 ; Guatemala, 105,587 ; Honduras Republic, 75,015 ; Colombia, 68,493 ; Brazil, 59,556 ; Canary Islands, 13,700 ; Cuba, 12,248 ; Trinidad, 4,121 ; Gold Coast, 3,365.